



(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.03.2002 Bulletin 2002/12

(51) Int Cl.7: **F04D 29/04**, **F04D 29/10**

(21) Application number: 01122201.5

(22) Date of filing: 17.09.2001

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
 MC NL PT SE TR**
 Designated Extension States:
AL LT LV MK RO SI

- Chiba, Atsushi
Toyoake-shi, Aichi-ken (JP)
- Chujo, Masaki
Chiryu-shi, Aichi-ken (JP)
- Yamamoto, Junya
Toyota-shi, Aichi-ken (JP)

(30) Priority: 19.09.2000 JP 2000284017
17.11.2000 JP 2000351665
09.03.2001 JP 2001067566

(74) Representative: **Barske, Heiko, Dr. rer. nat.**
Blumbach, Kramer & Partner
Patentanwälte
Radeckestrasse 43
81245 München (DE)

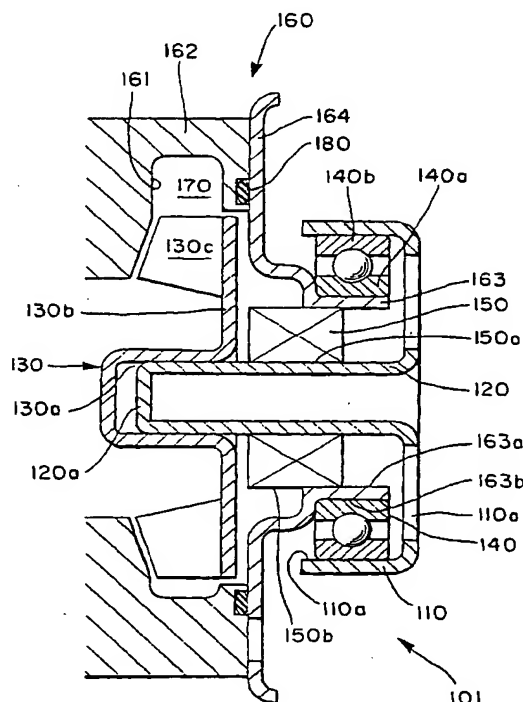
(71) Applicant: AISIN SEIKI KABUSHIKI KAISHA
Kariya-shi Aichi-ken (JP)

(72) Inventors:
• **Ozawa, Yasuo**
Kariya-shi, Aichi-ken (JP)

(54) **Water pump**

(57) To provide a water pump capable of preventing coolant leaked from a shaft sealing member from invading a bearing by a simple constitution, in a water pump 101 in which an outer ring 140b of a bearing 140 is attached to an inner peripheral face 110a of a pulley 110, an inner ring 140a of the bearing 140 is attached to an outer peripheral face 163b of a cylindrical portion 163 of a housing 160 and a shaft sealing member 150 is attached to an inner peripheral face 163a of the cylindrical portion 163.

FIG. 1



EP 1 188 931 A2

BEST AVAILABLE COPY

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a water pump for circulating a coolant of an internal combustion engine.

DESCRIPTION OF THE RELATED ART

[0002] In Japanese Patent Laid-Open No. 262096/1992, there is disclosed a water pump in which a support portion in a cylindrical shape surrounding a rotating shaft is provided at a pump case, an outer end of the rotating shaft projected outwardly from the support portion, is integrally coupled with a pulley formed in a cylindrical shape surrounding the support portion, a bearing is interposed between an inner face of the pulley and an outer face of the support portion and only a seal member arranged concentrically with the bearing is interposed between an inner face of the support portion and the rotating shaft.

[0003] As shown by Fig. 12, the water pump disclosed in Japanese Patent Laid-Open No. 262096/1992, is provided with the support portion or a body 2A fixed to an attaching face of a cylinder block of an internal combustion engine, a pulley portion 40A rotated by a transmission member, a shaft portion 50A in a solid shape coaxially connected to a central region of the pulley portion 40A, a bearing 6A provided between the body 2A and the pulley portion 40A for making the pulley portion 40A rotatable relative to the body 2A and a rotating blade member 8A fitted and fixed to the shaft portion 50A. When a crankshaft of the internal combustion engine is driven, a belt 49A constituting the transmission member hung at the crankshaft and the pulley portion 40A is operated to circulate to thereby rotate the pulley portion 40A. When the pulley portion 40A is rotated, the shaft portion 50A connected to the pulley portion 40A is rotated in the same direction and the rotating blade member 8A is rotated in a pump chamber of the internal combustion engine. As a result, pumping operation is achieved.

[0004] Further, according to Japanese Patent Laid-Open No. 149822/1990, there is disclosed a water pump in which a pulley is arranged in a state of surrounding a bearing support portion of a pump housing, a drain hole is formed at a lower portion of a buffer chamber formed between a seal member arranging portion and a bearing arranging portion of the bearing support portion, the drain hole is opened to an inner face of the pulley and a water storing portion is formed at the inner face of the pulley.

[0005] Meanwhile, according to the conventional water pumps, when a coolant leaked from a shaft sealing member (mechanical seal) invades the bearing, there is caused a drawback in which the bearing is corroded, the sliding resistance is increased or the bearing is destructed.

[0006] Therefore, according to the conventional water pumps, in order to prevent the coolant leaked from the shaft sealing member from invading the bearing, a plurality of seal members are interposed between an inner face of a support portion of the housing and the rotating shaft other than the shaft sealing member. However, although according to such a constitution, the coolant can be prevented from invading the bearing, there poses a problem that a number of parts attached to the housing is increased, shapes or fabrication of the parts become complicated and cost of the parts is increased since both of the shaft sealing member and the seal members are needed.

[0007] Further, according to the water pump shown in Fig. 12, the shaft portion in the solid shape projected to the side of the pump chamber and the pulley portion are separate from each other, when the water pump is integrated, the pulley portion and the shaft portion in the solid shape are successively connected and therefore, aspects of light-weighted formation and integration performance are not necessarily satisfactory.

[0008] In addition thereto, according to the water pump of the conventional technology (for example, Japanese Patent Laid-Open No. 149822/1990), a liquid leaked from the water storing portion formed at the inner face of the pulley reaches a belt engaging face of the pulley by way of an outer peripheral face of the pulley. As is well known, transmission of rotational force by the pulley is carried out by rotating the shaft by friction force operated between the belt and the pulley by the belt constituting rotational force transmitting means and therefore, when the liquid is adhered to the belt engaging face of the pulley, there is a concern of reducing the friction force and causing loss in transmitting the rotational force. Further, the belt is generally constituted by rubber and therefore, there poses a problem that the belt is swollen by adhering the liquid and its strength is lowered.

SUMMARY OF THE INVENTION

[0009] Therefore, it is a technical problem of the invention to provide a water pump capable of preventing coolant leaked from a shaft sealing member from invading a bearing by a small-sized, light-weighted and simple constitution.

[0010] Further, it is a technical problem of the invention to be resolved, in addition to the above-described problem, to provide a water pump capable of ensuring drawability of a shaft portion integrally formed with a pulley portion of a pulley member and advantageous in shortening a length of the shaft portion.

[0011] Further, it is a technical problem of the invention to provide a water pump capable of preventing a liquid leaked from a shaft sealing member from reaching a belt engaging face by a small-sized, light-weighted and simple constitution.

[0012] According to an aspect of the invention, the

above-described problems are resolved by providing a water pump comprising:

a pulley rotated by receiving a torque from a drive source and having a shaft portion which is integrally formed therewith and extended in a shaft core direction at a central portion thereof;
 an impeller fixed to the shaft portion and rotated integrally with the shaft portion;
 a body forming a water chamber arranged with the impeller;
 a cylindrical portion provided by projecting from the body in a cylindrical shape;
 a bearing rotatably supporting the pulley at the cylindrical portion; and
 a shaft sealing member for sealing the bearing against the water chamber;

wherein the shaft sealing member is attached to either one of an inner peripheral face and an outer peripheral face of the cylindrical portion .

[0013] Preferably, the shaft portion includes a hollow chamber, the impeller includes a central boss portion, and blades and the central boss portion is fitted to an inner portion of the shaft hollow chamber of the shaft portion.

[0014] An outer ring of the bearing is attached to an inner peripheral face of the pulley, an inner ring thereof is attached to an outer peripheral face of the cylindrical portion and the shaft sealing member is attached to an inner peripheral face of the cylindrical portion and the pulley is provided with a projected portion projected to an outer side in a diameter direction in a space between the shaft sealing member of the pulley and the bearing.

[0015] According to a preferable example of the invention, the inner ring of the bearing is attached to the outer peripheral face of the cylindrical portion formed at the body and the shaft sealing member is attached to the inner peripheral face of the cylindrical portion and therefore, at least portions of the shaft sealing member and the bearing in the axial direction, which have conventionally been arranged at positions extended in the axial direction, can be arranged to overlap and the length of the shaft portion of the water pump in the axial direction can be shortened. Thereby, the water pump is downsized and its mountability can be promoted.

[0016] The pulley member used in the invention is provided with a pulley portion rotated by a wrapping transmission member such a belt and the shaft portion integral with the pulley portion. The shaft portion is provided at a central region of the pulley portion by squeeze-drawing substantially coaxially therewith. The shaft portion is constituted by a cylindrical shape penetrated in the axial length direction and is provided with the shaft hollow chamber extended in the axial length direction, a front end opening disposed on a front end side of the shaft hollow chamber and a base end opening disposed on a base end side of the shaft hollow

chamber. In this way, the shaft portion is constituted by the cylindrical shape penetrated in the axial length direction and is constituted by unbottomed hollow shape which is not provided with a bottom wall portion and therefore, in comparison with a case of a bottomed hollow portion having the bottom wall portion, squeeze-drawability of a peripheral wall of the shaft portion is excellently ensured.

[0017] Further, a central boss portion of a rotating blade member is fitted to an inner portion of the shaft hollow chamber of the shaft portion of the pulley member and therefore, in comparison with the case in which the central boss portion of the rotating blade member is fitted to an outer portion of the shaft portion of the pulley member, a projecting degree of projecting a front end portion in the axial length direction of the shaft portion to a side of the rotating blade member is reduced and therefore, the constitution is advantageous in shortened formation of the axial length of the shaft portion and also in this regard, the squeeze-drawability of the shaft portion is excellently ensured.

[0018] Further, according to a preferable example of the invention, a liquid leaked from the shaft sealing member is dropped at a portion, provided at the pulley and projected to an outer side in the diameter direction. Thereby, a water cutting effect is achieved and the liquid can be prevented from adhering to the belt by flowing the liquid to the belt engaging face of the pulley engaged with the belt.

[0019] The projected portion of the pulley a can store the liquid by an amount of its volume (predetermined amount) . At this occasion, the level of the stored liquid can always be made to be lower than the inner peripheral face of the belt engaging face by adjusting means and therefore, the stored liquid can be prevented from invading the inner peripheral face of the belt engaging face.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a sectional view of a water pump showing a first embodiment of the invention;

Fig. 2 is a sectional view of a water pump showing a second embodiment of the invention;

Fig. 3 is a sectional view of essential portions of a water pump showing a third embodiment of the invention;

Fig. 4 is a sectional view of essential portions of a water pump showing a fourth embodiment of the invention;

Fig. 5 is a sectional view of a water pump according to a fifth embodiment;

Fig. 6 is a sectional view of a water pump according to a sixth embodiment;

Fig. 7 is a sectional view of a water pump according to a seventh embodiment;

Fig. 8 is a sectional view of a water pump showing an eighth embodiment of the invention;
 Fig. 9 is a front view of the water pump showing the eighth embodiment of the invention;
 Fig. 10 is a sectional view of a water pump showing a ninth embodiment of the invention;
 Fig. 11 is a front view of the water pump showing the ninth embodiment of the invention; and
 Fig. 12 is a sectional view of a water pump according to a conventional technology.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Fig. 1 is a sectional view of a water pump showing a first embodiment of the invention.

[0022] In Fig. 1, a water pump 101 is constituted by a pulley 110, an impeller 130, a bearing 140, a shaft sealing member 150, a housing (body) 160 and a seal member 180.

[0023] The pulley 110 is formed in a shape of a cylindrical cup and at center of the bottom face, there is formed a shaft portion 120 projected in a cylindrical shape in a direction remote from the bottom face. Outer peripheral faces of the shaft portion 120 and the pulley 110 are concentrically arranged. The pulley 110 is formed by pressing a plate-like member such as a steel plate subjected to a corrosion resistant processing. Namely, the pulley 110 having a pulley member and the shaft portion 120 is formed from one sheet of a metal plate member by a pressing and/or squeezing process. The shaft portion 120 is formed in a shape of a hollow cylinder as illustrated.

[0024] The impeller 130 is an impeller of a so-to-speak open type having a base portion 130b and several sheets of blades 130c projected therefrom. There is formed a recess portion 130a for attaching the shaft portion 120 at center of the base portion 130b of the impeller 130. The recess portion 130a and the shaft portion 120 are attached unrotatably relative to each other by press-fitting in this embodiment.

[0025] The housing 160 is constituted by a main body portion 162 having a suction port, a delivery port, not illustrated and a recess portion 161 and a body bottom portion 164 attached to an end face of the main body portion 162. The main body portion 162 may be formed by an aluminum die-cast product or may be constituted integrally with a cylinder block or a timing belt case of an engine.

[0026] The body bottom portion 164 is formed substantially in a shape of a circular disk and a cylindrical portion 163 having a diameter smaller than an outer diameter of the main body portion 162, is formed to project in a direction remote from the main body portion 162 at a vicinity of its center. The body bottom portion 164 is formed by pressing a plate-like member such as a steel plate subjected to a corrosion preventive processing. The main body portion 162 and the body bottom portion

164 are coupled by bolts, not illustrated, via the seal member 180. Thereby, there is formed a space maintaining water-tightness between the recess portion of the main body portion 162 and the body bottom portion 164.

[0027] The space constitutes a water chamber 170 and the impeller 130 is arranged in the water chamber 170.

[0028] An inner peripheral face 163a of the cylindrical portion 163 of the body bottom portion 164, is attached with an outer peripheral face 150b of the shaft sealing member 150 unrotatably relative to each other by press-fitting. Further, also an outer peripheral face of the shaft portion 120 is attached with an inner peripheral face 150a of the shaft sealing member 150 similarly by press-fitting. Here, the inner and the outer peripheral faces 150a and 150b are made rotatable relative to each other, although not illustrated. The shaft portion 120 is rotatably supported relative to the housing 160 by the shaft sealing member 150. Here, the shaft sealing member 150 is a publicly-known mechanical seal.

[0029] Further, an outer peripheral face 163b of the cylindrical portion 163 of the body bottom portion 164 is attached with an inner ring 140a unrotatably relative to each other by press-fitting. Meanwhile, an inner peripheral face of the pulley 110 is attached with an outer ring 140b of the bearing 140 unrotatably relative to each other by press-fitting. Here, the bearing 140 is a publicly-known rolling bearing.

[0030] Thereby, the pulley 110 is supported by the housing 160 rotatably relative to each other by the bearing 140.

[0031] With regard to positions of the shaft sealing member 150 and the bearing 140, in the axial direction, at least portions of respective members are arranged to overlap.

[0032] Next, an explanation will be given of operation of the first embodiment.

[0033] The pulley 110 is rotated by rotational force transmitted from an output shaft of an engine, not illustrated, via the belt, not illustrated, expanded to an outer peripheral face of the pulley 110. With rotation of the pulley 110, the shaft portion 120 integrally formed with the pulley 110 is also rotated in the same direction. Further, the impeller 130 integrated with the shaft portion 120 is rotated in the water chamber 170 in the housing 160.

[0034] Now, the coolant is filled in the water chamber 170 and therefore, by centrifugal force produced by rotating the impeller 130, the coolant disposed at a vicinity of a center of the water chamber 170 is delivered by the impeller 130 in an outer peripheral direction of the impeller 130. In this way, there is produced pumping operation by the centrifugal force from the center of the impeller 130 to its outer side. Thereby, there is produced a pressure difference between the vicinity of the rotational center of the impeller 130 and its outer peripheral side in the water chamber 170 and the coolant is sucked from an intake port, not illustrate, provided at the vicinity

of the rotational center of the impeller 130 into the water pump 101.

[0035] Further, the coolant is pressurized to the outer peripheral side by the pumping operation of the impeller 130 and supplied from a delivery port, not illustrated, provided on the outer peripheral side to respective portions to be cooled of the engine.

[0036] Whereas the coolant is filled in the water chamber 170, the pulley 110 is opened through a plurality of openings 110a to the atmosphere. However, an interval between the main body portion 162 and the body bottom portion 164 is hermetically closed by the seal member 180 and the shaft portion 120 is hermetically closed by arranging the shaft sealing member 150.

[0037] As described above, according to the first embodiment, the bearing 140 and the shaft sealing member 150 are attached to the same member, that is, the outer peripheral face 163b and the inner peripheral face 163a of the cylindrical portion 163 of the body bottom portion 164. Thereby, the bearing 140 and the shaft sealing member 150 which has been arranged to align in the axial direction conventionally, can be arranged at the same position in the axial direction at least partially, that is, the both members can be arranged to overlap in the axial direction. Therefore, the length of the water pump 101 in the axial direction can be shortened and mountability of the water pump 1 to the engine can be promoted.

(Second embodiment)

[0038] Fig. 2 is a sectional view of a water pump 201 showing a second embodiment of the invention. Fig. 2 differs from Fig. 1 only in portions of shapes of a shaft portion 220 and a body bottom portion 264, the other constitution is the same as that of the first embodiment and therefore, there are used numerical notations produced by adding 200 to numeral notations of Fig. 1 and an explanation will be omitted with regard to a constitution duplicated with that of the first embodiment.

[0039] In Fig. 2, there is provided a through hole 220b at an end face 220a of the shaft portion 220. The through hole 220b is used in attaching an impeller 230 to the shaft portion 220 unrotatably relative to each other by press-fitting for positioning the impeller 230 in the axial direction. When a clearance between a blade 230c of the impeller 230 and a housing 260 is large, a pumping function of the impeller 230 is deteriorated and when the clearance is small, there is a possibility of making the impeller 230 collide with the housing 260. Therefore, high accuracy is needed in a position of attaching the impeller 230 and the shaft portion 220 in the axial direction.

[0040] However, by providing the through hole 220b at the end face 220a of the shaft portion 220, the impeller 230 and the shaft portion 220 can be attached while measuring positions thereof by inserting a jig and accordingly, the impeller 230 can be attached thereto ac-

curately in its position in the axial direction.

[0041] Meanwhile, a distance between a pulley 210 and the impeller 230 in the axial direction is determined by a length of the shaft portion 220 connecting the both members. Therefore, a length to some degree is needed in the shaft portion 220. However, when a slender hollow shape is formed from a plate-like member by pressing, wrinkle or crack may be caused at a portion constituting a bottom of the slender hollow shape (corresponding to the end face 220a of the shaft portion 220). Therefore, by providing the through hole 220b at the end face 220a of the shaft portion 220, wrinkle or crack can be prevented from causing and formability in forming the pulley 210 can be promoted.

[0042] Further, at a side end face of a cylindrical portion 263 of the body bottom portion 264 on the side of the pulley 210, there is provided a flange portion 265 integrally formed by being folded to bend in a direction of contracting its diameter more than a diameter of an outer peripheral face 250b of a shaft sealing member 250 over an entire periphery of the cylindrical portion. There is formed a space 266 in a shape of a groove by the flange portion 265, the shaft sealing member 250 and an inner peripheral face 263a of the cylindrical portion 263. The space 266 in the groove-like shape operates as follows. Very small leakage of the coolant may be caused at the shaft sealing portion 250 as its characteristic.

[0043] However, the coolant leaked from the shaft sealing member 250 is temporarily stored at the groove-like space 266 by the groove-like space 266 formed by the shaft sealing member 250, the inner peripheral face 263a of the cylindrical portion 263 and the flange portion 265. An amount of the coolant leaked from the shaft sealing member 250 is very small and therefore, the coolant hardly overflows from the groove-like space 266 and reaches a vicinity of a bearing 240.

[0044] Further, the leaked coolant stored at the groove-like space 266 evaporates by friction heat generated by rotating the bearing 240, discharged to outside from holes 210a formed at the pulley 210 and the leaked coolant does not reach the vicinity of the bearing 240.

[0045] As described above, according to the second embodiment, by providing the through hole 220b at the end face 220a of the shaft portion 220, there can be promoted accuracy in the attaching position in the axial direction when the impeller 230 is attached to the shaft portion 220 and the formability of the shaft portion 220 and the pulley 210 can be promoted.

[0046] Further, by providing the flange portion 265 formed by folding to bend the end face of the cylindrical portion 263 on the side of the pulley 210 in the direction of contracting the diameter more than the diameter of the outer peripheral face 250b of the shaft sealing member 250 over the entire periphery of the cylindrical portion 263, there can be provided the groove-like space 266 capable of temporarily storing the coolant leaked

from the shaft sealing member 250 and the leaked coolant can be prevented from invading the vicinity of the bearing 240.

(Third embodiment)

[0047] Fig. 3 is a sectional view of essential portions of a water pump 301 showing a third embodiment of the invention. Fig. 3 differs from Fig. 1 partially in a shape of a body bottom portion 364 and the other constitution is the same as that of the first embodiment and therefore, there are used numeral notations produced by attaching 300 to numeral notations of Fig. 1 and an explanation will be omitted with regard to a constitution duplicated with that of the first embodiment.

[0048] In Fig. 3, at an end face of a cylindrical portion 363 of the body bottom portion 364 on the side of a pulley 310, there is provided a flange portion 365 integrally formed by being folded to bend to a direction of enlarging its diameter more than the diameter of an inner ring 340a of a bearing 340. A clearance between the flange portion 365 and the bearing 340 in the axial direction is formed to be very small. Thereby, there can be formed a labyrinth shape 366 having a very small clearance between an end face of the bearing 340 on the side of the pulley 310 and an end face of the flange portion 365 on a side of a housing 360. By the labyrinth shape 366, the coolant leaked from a shaft sealing member 350 is difficult to invade an end face of the bearing 340.

[0049] As described above, according to the third embodiment, by the flange portion 365 integrally formed by being folded to bend in the direction of enlarging the diameter of the end face of the cylindrical portion 363 of the body bottom portion 364 on the side of the pulley 310 more than the inner ring 340a of the bearing 340, the labyrinth shape 366 can be formed at the end face of the bearing 340 on the side of the pulley 310. Thereby, the coolant produced and leaked from the shaft sealing member 350 can be prevented from invading from the end face of the bearing 340 to inside of the bearing 240.

(Fourth embodiment)

[0050] Fig. 4 is a sectional view of a water pump showing a fourth embodiment of the invention.

[0051] Fig. 4 differs from Fig. 1 partially in a shape of a body bottom portion 464, the other constitution is the same as that of the first embodiment and therefore, there are used numerical notations produced by adding 400 to numeral notations of Fig. 1 and an explanation will be omitted with regard to a constitution duplicated with that of the first embodiment.

[0052] The body bottom portion 464 is provided with a cylindrical portion 467 having a small diameter attached with an inner ring of a bearing 440. Further, there is provided a cylindrical portion 468 having a large diameter attached with an outer peripheral face of a shaft sealing member 450 further to the side of a main body

462. The cylindrical portions 467 and 468 are constituted by a member the same as that of the body bottom portion 464. The cylindrical portion 467 having the small diameter and the cylindrical portion 468 having the large diameter are formed in a step-like shape.

[0053] Thereby, a shaft sealing member 450 and the bearing 440 can be arranged to overlap in their diameter directions and therefore, the size of a pulley 410 in the diameter direction can be reduced. Thereby, the mountability of the water pump to the engine can be promoted.

[0054] Further, the inner diameter of the bearing may be smaller than the outer diameter of the shaft sealing member and therefore, the bearing can be downsized and mass and cost thereof can be reduced.

(Fifth embodiment)

[0055] A specific explanation will be given of a fifth embodiment of the invention in reference to Fig. 5 as follow.

[0056] A cylinder block 510 constituting an internal combustion engine 501 which is a base portion attached with a water pump, is formed with a pump chamber 511 communicating with a cooling water path to open at an attaching face 513.

[0057] In Fig. 5, an arrow mark X1 direction indicates a direction directed from outside to an inner portion of the cylinder block 510 of the internal combustion engine 501 in an axial length direction of a shaft portion 550. An arrow mark X2 direction indicates a direction from the inner portion of the cylinder block 510 of the internal combustion engine 501 to outside in the axial length direction of the shaft portion 550.

[0058] The water pump is fixed to the attaching face 513 of the cylinder block 510 and is provided with a body 502, a pulley member 504, a bearing 506 and a rotating blade member 508. The body 502 is fixed to the attaching face 513 of the cylinder block 510 constituting the internal combustion engine 501 by bolts, not illustrated, penetrating attaching holes 502x. The body 502 is formed by pressing or form-rolling one sheet of a plate member made of metal (generally, steel species).

[0059] The body 502 is provided with an attaching flange portion 520 provided to the attaching face 513 of the cylinder block 510 via a seal portion 514 in a ring-like shape and a cylindrical portion 521 formed at a central region of attaching flange portion 520.

[0060] The cylindrical portion 521 is constituted by a shape of a stepped hollow cylinder and is provided with a first cylindrical portion 522 along the axial length direction, a second cylindrical portion 523 along the axial length direction having a diameter set to be smaller than a diameter of the first cylindrical portion 522, a third cylindrical portion 524 along the axial length direction having a diameter set to be smaller than the diameter of the second cylindrical portion 523, a first erected wall portion 525 along a direction orthogonal to the axial direction connecting the first cylindrical portion 522 and the

second cylindrical portion 523 and a second erected wall portion 526 along the direction orthogonal to the axial direction connecting the second cylindrical portion 523 and the third cylindrical portion 524.

[0061] The pulley member 504 is made of metal and is provided with a pulley portion 540 rotated by a belt 549 as a wrapping transmission member circulated by a crankshaft of the internal combustion engine 501 and is provided with a shaft portion 550 constituting a shape of a hollow cylinder penetrating in the axial length direction. The pulley member 504 comprising the pulley portion 540 and the shaft portion 550 is formed from one sheet of a plate member made of metal. The pulley portion 540 is provided with an outer ring portion 541 along the axial length direction and an erected wall portion 542 along the direction orthogonal to the axial direction and is formed by pressing.

[0062] The shaft portion 550 is formed in a shape of a hollow cylinder by squeeze-drawing and is formed substantially coaxially with the pulley portion 540 to be continuous from an inner peripheral side of the erected wall portion 542 of the pulley portion 540. The shaft portion 550 is provided with a shaft hollow chamber 551 partitioned by a peripheral wall and extended in the axial length direction. A front end opening 552 disposed on a front end side (side of the cylinder block 510 of the internal combustion engine 501) of the shaft hollow chamber 551 and a base end opening 553 disposed on a base end side (side reverse to the cylinder block 510 of the internal combustion engine 501) of the shaft hollow chamber 551.

[0063] The shaft portion 550 is light-weighted by constituting a cross-sectional face thereof by a hollow cylindrical shape in a circular shape. Therefore, the diameter of the shaft portion 550 is substantially made constant along the axial length direction, however, the diameter is not limited thereto. According to the embodiment, as shown by Fig. 5, although a front end 550p of the shaft portion 550 is extended in the arrow mark X1 direction along the axial length direction, the front end 550p does not reach the pump chamber 511 of the cylinder block 510 of the internal combustion engine 501 and does not reach the attaching face 513 of the cylinder block 510. However, the invention is not limited thereto.

[0064] The bearing 506 makes the pulley member 504 rotatable relative to the body 502 and is provided with an outer ring 560 in a ring-like shape, an inner ring 561 in a ring-like shape and a plurality of rolling bodies 562 interposed therebetween. The bearing 506 is held between the body 502 and the pulley member 504. Specifically, the bearing 506 is provided between an outer peripheral face of the third cylindrical portion 524 having a small diameter in the cylindrical portion 521 of the body 502 and an inner peripheral face of the outer ring portion 541 of the pulley portion 540.

[0065] Therefore, an inner peripheral face of the bearing 506 is held by the third cylindrical portion 524 of the body 502 and an outer peripheral face of the bearing

506 is held by the outer ring portion 541 of the pulley portion 540. In this way, the bearing 506 is held by utilizing the third cylindrical portion 524 having the smallest diameter in the cylindrical portion 521 of the body 502 and therefore, downsizing of the diameter of the bearing 506 can be dealt with.

[0066] According to the embodiment, the third cylindrical portion 524 of the body 502 and the inner peripheral face of the bearing 506 are fixedly press-fitted. The outer ring portion 541 of the pulley portion 540 of the pulley member 504 and the outer peripheral face of the bearing 506 are fixedly press-fitted. By fixedly press-fitting these members, holding performance with regard to the bearing 506 is ensured and detachment preventive performance of the bearing 506 is promoted. Further, the second erected wall portion 526 of the cylindrical portion 521 of the body 502 is provided to an axial end 506a (side opposed to the cylinder block 510 of the internal combustion engine 501) of the bearing 506 as a stopper, the holding performance with regard to the bearing 506 is further ensured and the detachment preventive performance of the bearing 506 is further promoted.

[0067] The rotating blade member 508 is formed by pressing, made of metal and is provided with a central boss portion 580 subjected to squeeze-drawing and a plurality of blades 586 integrally held by the central boss portion 580. The central boss portion 580 is disposed on a side reverse to the blades 586 in the axial length direction of the shaft portion 550.

[0068] The central boss portion 580 of the rotating blade member 508 is constituted by a bottomed hollow shape and is provided with a pipe body 582 having a hollow chamber 581 and a closed wall 583 for closing a front end side of the hollow chamber 581 of the pipe body 582. The central boss portion 580 provided on the side reverse to the blades 586 of the rotating blade member 508, is fixedly press-fitted to an inner portion of the shaft hollow chamber 551 of the shaft portion 550 of the pulley member 504. In other words, an outer wall face of the pipe body 582 of the central boss portion 580 of the rotating blade member 508 is press-fitted to an inner wall face of the pulley member 504 partitioning the shaft hollow portion 551 of the shaft portion 550.

[0069] As shown by Fig. 5, the closed wall 583 of the central boss portion 580 of the rotating blade member 508, advances into the shaft hollow chamber 551 in a penetrated state of the shaft portion 550 of the pulley member 504, closes inside of the shaft hollow chamber 551, brings inside of the shaft hollow chamber 551 into a non-communicated state and prevents water in the pump chamber 511 of the cylinder block 510 from leaking to the shaft hollow chamber 551 of the shaft portion 550.

[0070] Further, the hollow chamber 581 of the pipe body 582 of the rotating blade member 508 is directly opposed to the pump chamber 511 of the cylinder block 510. In this case, the constitution is advantageous in in-

creasing the volume of the pump chamber 511.

[0071] Sealing means 509 is provided by utilizing press-fitting between the shaft portion 550 of the pulley member 504 and the body 502. The sealing means 509 is formed by a seal plate 590 in a ring-like shape provided between the second cylindrical portion 523 of the body 502 and the shaft portion 550 for sealing the pump chamber 511 and a publicly-known mechanical seal 591. By the sealing means 509, water in the pump chamber 511 of the cylinder block 510 is prevented from leaking to the side of the bearing 506.

[0072] As shown by Fig. 5, a double wall structure is constituted by the peripheral wall of the shaft portion 550 and the peripheral wall of the pipe body 582 of the rotating blade member 508 and therefore, the constitution is advantageous in strengthening the shaft portion 550 provided with the sealing means 509. Further, there is formed a clearance 529 in a ring-like shape between the third cylindrical portion 524 of the cylindrical portion 521 of the body 502 and the shaft portion 550. Further, the clearance 529 is covered by the pulley portion 540 and therefore, the clearance 529 cannot be visually recognized from outside.

[0073] In using the embodiment, there is hung the belt 549 in an endless shape constituting the wrapping transmission member over the crankshaft of the internal combustion engine 501 and the outer ring portion 541 of the pulley portion 540 of the pulley member 504.

[0074] When the crankshaft is driven by driving the internal combustion engine 501 and the belt 549 is circulated, the pulley member 504 comprising the pulley portion 540 and the shaft portion 550 is rotated integrally therewith. Therefore, the blades 586 of the rotating blade member 508 connected to the shaft portion 550 are rotated in the same direction at inside of the pump chamber 511 of the internal combustion engine 501, water in the pump chamber 511 is delivered in the centrifugal direction, pumping operation by the blades 586 is achieved and water for cooling is circulated at inside of water paths, not illustrated, of the cylinder block 510.

[0075] As explained above, according to the embodiment, the pulley member 504 is provided with the pulley portion 540 rotated by the belt 549 and the shaft portion 550 integral with the pulley portion 540, the shaft portion 550 is constituted by the shape of the hollow cylinder penetrated in the axial length direction and is provided with the shaft hollow chamber 551, the front end opening 552 disposed on the front end side of the shaft hollow chamber 551 and the base end opening 553 disposed on the base end side of the shaft hollow chamber 551.

[0076] In this way, the shaft portion 550 is constituted by the shape of the hollow cylinder penetrating in the axial length direction and is formed by a unbottomed hollow shape which is not provided with a bottom wall portion and therefore, in comparison with the case of the bottomed hollow shape having the bottom wall portion, drawability (deep drawability) of the shaft portion 550 of the pulley member 504 is promoted.

[0077] Further, according to the embodiment, the central boss portion 580 of the rotating blade member 508 is fitted to inside of the shaft hollow chamber 551 of the shaft portion 550 of the pulley member 504. Therefore, different from the case in which the central boss portion of the rotating blade member is fitted to an outer portion of the shaft portion of the pulley member as shown by Fig. 12, a projecting degree for projecting the front end 550p in the axial length direction of the shaft portion 550 to the side of the rotating blade member 508 is reduced.

[0078] That is, the front end 550p in the axial length direction of the shaft portion 550 according to the embodiment may not be projected excessively to the side of the pump chamber 551 such that the front end 550p is much projected into the pump chamber 511 of the cylinder block 510.

[0079] In this way, according to the embodiment, the projecting degree of projecting the front end portion in the axial length direction of the shaft portion 550 of the pulley member 504 to the rotating blade member 508, that is, to the side of the pump chamber 511, is reduced and shortened formation of the axial length of the shaft portion 550 can be achieved. Also in this regard, the drawability (deep drawability) of the shaft portion 550 is ensured.

[0080] Therefore, according to the embodiment, even in the case of a severe drawing condition, uniform formation of a wall thickness in the peripheral wall of the shaft portion 550 is promoted. As a result, even in the case of rotating the pulley member 504, particularly, in the case of rotating the pulley member 504 at high speed, the constitution is further advantageous in balance formation of rotational balance in the shaft portion 550 of the pulley member 504.

[0081] When the rotational balance of the shaft portion 550 is further balanced in this way and deflection of the shaft core of the shaft portion 550 is further restrained, the constitution can contribute to further promoting reliability of the sealing means 509 provided at the vicinity of the shaft portion 550 and promotion of durability of the bearing 506 rotatably supporting the shaft portion 550 can also be achieved. Further, the rotational number of the pulley member 504 generally falls in a range of 700 through 10000 rpm although the rotational number differs by an operating situation of the internal combustion engine 501 (in starting, in operating at high speed).

[0082] Further, according to the embodiment, as described above, in comparison with the case in which the central boss portion of the rotating blade member is fitted to the outer portion of the shaft portion of the pulley member, the axial length of the shaft portion 550 can be shortened and therefore, the constitution can contribute to shifting the gravitational center of the rotating blade member 508 to the side of the bearing 506 in the axial length direction of the shaft portion 550 and is advantageous in rotating smoothly the rotating blade member 508.

[0083] Further, according to the embodiment, the second erected wall portion 526 of the cylindrical portion 521 of the body 502 is provided to the axial end 506a of the bearing 506 as the stopper to thereby ensure the holding performance and the detachment preventive performance with regard to the bearing 506.

[0084] Further, as shown by Fig. 5, the double wall structure is constituted by the peripheral wall of the shaft portion 550 and the peripheral wall of the pipe body 582 of the rotating blade member 508 and therefore, the constitution is advantageous in strengthening the shaft portion 550.

[0085] In this case, when there can be expected work hardening of the peripheral wall of the shaft portion 550 subjected to squeeze-drawing and the pipe body 582 of the rotating blade member 508 subjected to squeeze-drawing, the constitution is further advantageous to strengthening the peripheral wall of the shaft portion 550.

[0086] As described above, according to the embodiment, the shaft portion 550 is constituted by the cylindrical shape penetrating in the axial length direction and is constituted by the unbottomed hollow shape which is not provided with the bottom wall portion and therefore, the drawability is excellent. Therefore, even when the axial length dimension of the shaft portion 550 is set to be long, the constitution is advantageous in drawing the shaft portion 550 without hindrance and even in the case of adopting a design structure of setting the axial length of the shaft portion 550 to be longer by various situation, the constitution is advantageous in dealing therewith.

(Sixth embodiment)

[0087] An explanation will be given of a sixth embodiment of the invention in reference to Fig. 6 as follows. The sixth embodiment is provided with a constitution basically similar to that of the fifth embodiment and achieves operation and effect basically similar to those of the fifth embodiment. Portions common to those of the fifth embodiment are provided with common notations.

[0088] An explanation will be given centering on different portions as follows. Also according to the embodiment, a pulley member 604 is provided with a pulley portion 640 rotated by a belt 649 constituting a wrapping transmission member and a shaft portion 650 integral with the pulley portion 640. The shaft portion 650 is formed by squeeze-drawing to constitute a shape of a hollow cylinder penetrated in the axial length direction and is provided with a shaft hollow chamber 651, a front end opening 652 disposed on the front end side of the shaft hollow chamber 651 and a base end opening 653 disposed on the base end side of the shaft hollow chamber 651.

[0089] In this way, the shaft portion 650 is constituted by a cylindrical shape penetrated in the axial length direction and is constituted by an unbottomed hollow

shape which is not provided with a bottom wall portion and accordingly, drawability (deep drawability) of the shaft portion 650 of the pulley member 604 is ensured.

[0090] Further, also according to the embodiment, a central boss portion 680 of a rotating plate member 608 is fitted to an inner portion of the shaft hollow chamber 651 of the shaft portion 650 of the pulley member 604 and in comparison with the case in which the central boss portion 680 of the rotating blade member 608 is fitted to an outer portion of the shaft portion 650 of the pulley member 604, shortening of an axial length of the shaft portion 650 can be achieved.

[0091] Also in this regard, drawability (deep drawability) of the shaft portion 650 is ensured. That is, different from the case in which the central boss portion of the rotating blade member is fitted to the outer portion of the shaft portion of the pulley member as shown by Fig. 12 according to the conventional technology, the projecting degree of projecting a front end 650p in the axial length direction of the shaft portion 650 to the side of the rotating blade member 608, that is, to the side of a pump chamber 611 is reduced and the front end 650p in the axial length direction of the shaft portion 650 may not be projected excessively to the side of the pump chamber 611 such that the front end 650p is projected into the pump chamber 611 by a larger amount.

[0092] Therefore, according to the embodiment, even when a drawing condition is severe, uniform formation of a wall thickness of a peripheral wall of the shaft portion 650 formed by drawing is further achieved. As a result, even when the pulley member 604 is rotated, particularly, even when the pulley member 604 is rotated at high speed, balanced formation of the rotational balance is further promoted in the shaft portion 650 of the pulley member 604.

[0093] When the balanced formation of the rotational balance is further promoted and deflection of the shaft core of the shaft portion 650 of the pulley member 604 is further restrained, the constitution can contribute to further promoting reliability of sealing means 609 at a vicinity of the shaft portion 650 and further promotion of durability of a bearing 606 rotatably supporting the shaft portion 650 can be achieved.

[0094] A body 602 is formed by pressing or form-rolling one sheet of a plate member made of metal. As shown by Fig. 6, the body 602 is provided with an attaching flange portion 620 provided to an attaching face 613 of a cylinder block 610 via a seal portion 614 in a ring-like shape and a cylindrical portion 621 formed at a central region of the attaching flange portion 620.

[0095] The cylindrical portion 621 is provided with a first cylindrical portion 622 along the axial length direction, a second cylindrical portion 623 along the axial length direction having a diameter set to be smaller than a diameter of the first cylindrical portion 622, a third cylindrical portion 624 along the axial length direction having a diameter set to be smaller than the diameter of the second cylindrical portion 623, a first erected wall por-

tion 625 along a direction orthogonal to the axial direction for connecting the first cylindrical portion 622 and the second cylindrical portion 623 and a second erected wall portion 626 along the direction orthogonal to the axial direction for connecting the second cylindrical portion 623 and the third cylindrical portion 624.

[0096] The body 602 is provided with a first curved portion 631 for promoting holding performance of the bearing 606 provided to an axial end 606a of the bearing 606 (side opposed to the cylinder block 610 of an internal combustion engine 601) as a stopper. The first curved portion 631 is formed by curving the second erected wall portion 626. That is, as shown by Fig. 6, the second cylindrical portion 623, the second erected wall portion 626 and the third cylindrical portion 624, constitute substantially S-like shape in a section along the axial length direction of the shaft portion 650 and forms the first curved portion 631 provided to the axial end 606a of the bearing 606.

[0097] As shown by Fig. 6 the pulley portion 640 of the pulley member 604 is provided with a second curved portion 632 provided to an axial end 606c (side reverse to the cylinder block 610 of the internal combustion engine 601) of the bearing 606 as a stopper for promoting holding performance of the bearing 606. The second curved portion 632 is formed by curving an erected wall portion 642 of the pulley portion 640. In other words, the erected wall portion 642 of the pulley portion 640 is provided with a portion constituting substantially a C-like shape or a V-like shape in a section along the axial length direction of the shaft portion 650 and forms the second curved portion 632 provided to the axial end 606c of the bearing 606. Thereby, detachment preventive performance of the bearing 606 is promoted.

[0098] Further, between the third cylindrical portion 624 of the cylindrical portion 621 of the body 602 and an inner ring 661 of the bearing 606, an inserted member 694 on an inner side constituting a cylindrical shape is inserted substantially coaxially. Also between an outer ring portion 641 of the pulley portion 640 and an outer ring 660 of the bearing 606, an inserted member 696 on an outer side constituting a cylindrical shape is inserted substantially coaxially.

[0099] When the inserted member 696 on the outer side and the inserted member 694 on the inner side are inserted in this way, the constitution is advantageous in achieving adjustment of respective diameter sizes of the bearing 606, the pulley portion 640 and the body 602. Further, the inserted member 694 on the inner side and the inserted member 696 on the outer side are provided with high rigidity and therefore, the constitution is advantageous in supplementing rigidity of the outer ring portion 641 of the pulley portion 640 and rigidity of the third cylindrical portion 624 of the body 602 and the promotion of strength of integrating the water pump can be achieved.

[0100] Further, according to the embodiment, interference between the inserted member 696 on the other

side of the bearing 606 is set to be comparatively large and interference between the inserted member 694 on the inner side and the bearing 606 is set to be comparatively large. Further, interference between the inserted member 696 on the outer side and the outer ring portion 641 of the pulley member 604 is set to be comparatively small and interference between the inserted member 694 on the inner side and the body 602 is set to be comparatively small.

[0101] In Fig. 6, an arrow mark X1 direction indicates a direction directed from outside to an inner portion of the internal combustion engine 601 in the axial length direction of the shaft portion 650 and an arrow mark X2 direction indicates a direction remote from the inner portion of the internal combustion engine 601 to outside in the axial length direction of the shaft portion 650. An axial end 696a of the side of the internal combustion engine 601 of the inserted member 696 on the outer side, is projected in the arrow mark X1 direction more than the axial end 606a of the bearing 606. Also an axial end 641a of the outer ring portion 641 of the pulley portion 640 is projected in the arrow mark X1 direction to be remote from the bearing 606.

[0102] Further, the axial end 696a of the inserted member 696 on the outer side and the axial end 641a of the outer ring portion 641 of the pulley portion 640 projected in the arrow mark X1 direction to be remote from the bearing 606, described above, are connected by a welded portion 695. Thereby, the welded portion 695 can be remote from bearing 606 and the constitution is advantageous in alleviating or avoiding thermal effect from being effected to the bearing 606 in welding and can contribute to further promotion of reliability of the bearing 606.

[0103] As shown by Fig. 6, an axial end 694c (side reverse to the cylinder block 610 of the internal combustion engine 601) of the inserted member 694 on the inner side, is projected in a direction remote from the bearing 606, that is, in the arrow mark X2 direction. Also an axial end 624c (side reverse to the cylinder block 610 of the internal combustion engine 601) of the third cylindrical portion 624 of the cylindrical portion 621 of the body 602, is projected in the arrow mark X2 direction to be remote from the bearing 606.

[0104] The axial end 694c of the inserted member 694 on the inner side projected in the arrow mark X2 direction to be remote from the bearing 606 and the axial end 624c of the third cylindrical portion 624 of the cylindrical portion 621 of the body 602, described above, are connected by a welded portion 697. Thereby, the welded portion 697 can be remote from the bearing 606 and the constitution is advantageous in alleviating or avoiding thermal influence from being effected to the bearing 606 in welding and can further contribute to promotion of reliability of the bearing 606.

[0105] In recent years, further promotion of reliability of the belt 649 is more and more requested. The outer ring portion 641 of the pulley portion 640 is hung with

the belt 649 and therefore, when strain is caused at the outer ring portion 641 of the pulley portion 640, the constitution is not preferable in view of achieving further promotion of reliability of the belt 649.

[0106] In this respect, as shown by Fig. 6, according to the embodiment in which the welded portion 695 is formed at the axial end 641a projected in the arrow mark X1 direction in the outer ring portion 641 of the pulley portion 640, the constitution is advantageous in restraining strain of the outer ring portion 641 of the pulley portion 640 in welding, further, the welded portion 695 can be as remote as possible from the belt 649 hung on an outer peripheral face of the outer ring portion 641.

[0107] Therefore, the belt 649 can be restrained from being hung at a thermally affected portion of welding, which is advantageous in promoting reliability of the belt 649. Further, in place of the welded portions 695 and 697, the inserted member 694 on the inner side and the body 602 may be connected by calked portions or bolts and the inserted member 696 on the outer side and the pulley member 604 may be connected thereby.

[0108] As shown by Fig. 6, the rotating blade member 608 is provided with the central boss portion 680 subjected to deep drawing and a plurality of blades 868 integrally held by the central boss portion 680. The central boss portion 680 is disposed on a side reverse to the blades 868 in the axial length direction of the shaft portion 650.

[0109] The central boss portion 680 of the rotating blade member 608 is constituted by a bottomed hollow shape and is provided with a pipe body 682 having a hollow chamber 681 and a closed wall 683 for closing a front end side of the hollow chamber 681 of the pipe body 682. The central boss portion 680 provided on the side reverse to the blades 868 of the rotating blade member 608, is fixedly press-fitted to the inner portion of the shaft hollow chamber 651 of the shaft portion 650 of the pulley member 604.

[0110] In other words, an outer wall face of the pipe body 682 of the central boss portion 680 of the rotating blade member 608, is press-fitted to an inner wall face partitioning the shaft hollow chamber 651 of the shaft portion 650 of the pulley member 604. The closed wall 683 of the central boss portion 680 of the rotating blade member 608, closes to bring the shaft hollow chamber 651 in a communicated state of the shaft portion 650 of the pulley member 604 into a non-communicated state to thereby prevent water in the pump chamber 611 from leaking to the shaft hollow portion 651 of the shaft portion 650.

[0111] Further, the hollow chamber 681 of the pipe body 682 of the rotating blade member 608 is opposed to the pump chamber 611.

(Seventh embodiment)

[0112] A specific explanation will be given of a seventh embodiment of the invention in reference to Fig. 7

as follows. The seventh embodiment is provided with a constitution basically similar to that of the fifth embodiment and operation and effect specifically similar to those of the fifth embodiment are achieved. Notations common to those of the fifth embodiment are attached with common notations.

[0113] An explanation will be given centering on different portions as follows. Also according to the embodiment, a pulley member 704 is provided with a pulley portion 740 rotated by a belt 749 constituting a wrapping transmission member and a shaft portion 750 integral with the pulley portion 740. The shaft portion 750 is constituted by a cylindrical shape penetrated in the axial length direction and is provided with a shaft hollow chamber 751, a front end opening 752 disposed on a front end side of the shaft hollow chamber 751 and a base end opening 753 disposed on a base end side of the shaft hollow chamber 751.

[0114] In this way, the shaft portion 750 is constituted by the cylindrical shape penetrated in the axial length direction and is constituted by an unbottomed hollow shape which is not provided with a bottom wall portion and therefore, drawability (deep drawability) of the shaft portion 750 of the pulley member 704 is ensured.

[0115] Further, also according to the embodiment, a central boss portion 780 of a rotating blade member 708 is fitted to an inner portion of the shaft hollow chamber 751 of the shaft portion 750 of the pulley member 704 and can achieve shortened formation of axial length of the shaft portion 750 in comparison with the case in which the central boss portion 780 of the rotating blade member 708 is fitted to an outer portion of the shaft portion 750 of the pulley member 704.

[0116] Also in this regard, the drawability (deep drawability) of the shaft portion 750 is ensured. That is, the central boss portion 780 of the rotating blade member 708 can be arranged to be directed the pulley portion 740, that is, in an arrow mark X2 direction of Fig. 7 and accordingly, different from the case in which the central boss portion of the rotating blade member is fitted to the outer portion of the shaft portion of the pulley member as shown by Fig. 12 according to the conventional technology, a projecting degree for projecting a front end 750p in the axial length direction of the shaft portion 750 to a side of the rotating blade member 708, that is, to a side of a pump chamber 711, is reduced and the front end 750p in the axial length direction of the shaft portion 750 may not be projected excessively into the pump chamber 711.

[0117] Therefore, even when the drawing condition is severe, nonuniformity of wall thickness at a peripheral wall of the shaft portion 750 formed by drawing can be restrained. As a result, even when the pulley member 704 is rotated, particularly, even when the pulley member 704 is rotated at high speed, further balanced formation of rotational balance of the shaft portion 750 of the pulley member 704 can be achieved and the constitution can contribute to further promoting reliability of a

mechanical seal at a vicinity of the shaft portion 750 and can also achieve further promotion of durability of a bearing 706 rotatably supporting the shaft portion 750.

[0118] A body 702 is formed by pressing or form-rolling one sheet of a plate member made of metal. The body 702 is provided with an attaching flange portion 720 provided at an attaching face 713 of a cylinder block 710 via a seal portion 714 in a ring-like shape and a cylindrical portion 721 formed at a central region of the attaching flange portion 720.

[0119] The cylindrical portion 721 is constituted by a shape of a stepped cylinder and is provided with a first cylindrical portion 722 along an axial length direction, a second cylindrical portion 723 along the axial length direction having a diameter set to be larger than a diameter of the first cylindrical portion 722, a third cylindrical portion 724 along the axial length direction having a diameter set to be smaller than the diameter of the second cylindrical portion 723, a first erected wall portion 725 along a direction orthogonal to the axial direction for connecting the first cylindrical portion 722 and the second cylindrical portion 723 and a second erected wall portion 726 along the direction orthogonal to the axial direction for connecting the second cylindrical portion 723 and the third cylindrical portion 724.

[0120] The second cylindrical portion 723, the first erected wall portion 725 and the second erected wall portion 726 form a drain chamber 735. Even when water in the pump chamber 711 passes through sealing means 709, the water is stored in the drain chamber 735 of the body 702. Water excessively stored in the drain chamber 735 is discharged from a drain hole 736 of the second erected portion 726 of the body 702.

[0121] According to the embodiment, as shown by Fig. 7, an inner peripheral face of the bearing 706 is opposed to the shaft portion 750 and an outer peripheral face of the bearing 706 is opposed to the third cylindrical portion 724 of the body 702 via an inserted member 796. The shaft portion 750 of the pulley member 704 is constructed by a structure of a shaft having plural steps having a plurality of diameters (inner diameter, outer diameter). That is, the shaft portion 750 is provided with a first shaft portion 750m having a large diameter and a second shaft portion 750n coaxial therewith having a diameter set to be smaller than the diameter of the first shaft portion 750m.

[0122] In this way, the shaft portion 750 is constituted by a cylindrical shape having a plurality of steps and therefore, the diameter of the shaft portion 750 can be drawn to squeeze in steps from a large diameter to a small diameter, the squeeze-drawability of the shaft portion 750 is further improved and also the case of setting the axial length of the shaft portion 750 to be long is easy to deal with.

[0123] Therefore, as shown by Fig. 7, the front end 750p of the shaft portion 750 reaches the attaching face 713 of the cylinder block 710 of an internal combustion engine 701 in the arrow mark X1 direction and reaches

inside of the pump chamber 711 of the cylinder block 710 of the internal combustion engine 701. However, the invention is not limited thereto but the front end of the shaft portion 750 may not reach the attaching face 713 of the cylinder block 710 of the internal combustion engine 701 in the arrow mark X1 direction.

[0124] The bearing 706 in a ring-like shape is provided between the first shaft portion 750m having a diameter larger than the diameter of the second shaft portion 750n and the third cylindrical portion 724 of the body 702. Thereby, even a case in which the size of the diameter of the bearing 706 is large, can be dealt with. Further, when the size of the diameter of the bearing 706 is large, the constitution is advantageous in promotion of reliability and long life formation of the bearing 706.

[0125] As shown by Fig. 7, the pulley portion 740 of the pulley member 704 is provided with a second curved portion 732 provided to an axial end 706c (side reverse to the cylinder block 710 of the internal combustion engine 701) of the bearing 706 as a stopper for promoting holding performance of the bearing 706. The second curved portion 732 is formed by curving an erected wall portion 742 of the pulley portion 740. In other words, the erected wall portion 742 of the pulley portion 740 is provided with a portion constituting substantially a C-like shape or a V-like shape in a section along the axial length direction of the shaft portion 750 and forms the second curved portion 732 provided to the axial end 706c of the bearing 706 as the stopper. Thereby, detachment preventive performance of the bearing 706 is promoted.

[0126] As shown by Fig. 7, between the third cylindrical portion 724 of the body 702 and an outer ring 760 of the bearing 706, an inserted member 796 constituting a cylindrical shape is inserted substantially coaxially therewith. When the inserted member 796 is inserted therewith, the constitution is advantageous in achieving adjustment of respective diameter sizes of the bearing 706 and the body 702.

[0127] Further, the constitution is also advantageous in supplementing rigidity of the third cylindrical portion 724 of the cylindrical portion 721 of the body 702. An axial end 724c of the third cylindrical portion 724 of the body 702 on the side of the erected wall portion 742 of the pulley portion 740, is projected from the bearing 706 in an arrow mark X2 direction by ΔM (refer to Fig. 7).

[0128] An axial end 796c of the inserted member 796 on the side of the erected wall portion 742 of the pulley portion 740 is projected from the bearing 706 in the arrow mark X2 direction by ΔM (refer to Fig. 7). The axial end 796c of the inserted member 796 and the axial end 724c of the third cylindrical portion 724 of the body 702 projected from the bearing 706 in the arrow mark X2 direction in this way, are connected by a welded portion 798. By constituting in this way, the welded portion 798 can be remote from the bearing 706 and the constitution can contribute to promotion of reliability of the bearing

706 and can achieve further promotion of durability of the bearing 706.

[0129] Further, as shown by Fig. 7, the axial length of the inserted member 796 in the cylindrical shape is set to be longer than the axial length of the third cylindrical portion of the body 702. Therefore, an axial end 796a of the inserted member 796 on the side of the internal combustion engine 701 in the inserted member 796, is projected from the third cylindrical portion 724 of the body 702 by ΔK (refer to Fig. 7) to a side of the rotating blade member 708, that is, in the arrow mark X1 direction in the axial length direction of the shaft portion 701.

[0130] By utilizing the portion of the axial end 796a of the inserted member 796 projected in the arrow mark X1 direction in this way, a side of an axial end 706a of the bearing 706 is held. Thereby, the constitution is advantageous in approaching the bearing 706 to the side of the rotating blade member 708, that is, in the arrow mark X1 direction and can contribute to shortened formation of an axial length dimension of the water pump.

[0131] Further, in place of the welded portion 798, the inserted member 796 and the body 702 may be connected by a calked portion.

[0132] The rotating blade member 708 is provided with the central boss portion 780 subjected to deep drawing and a plurality of blades 786 integrally held by the central boss portion 780. The central boss portion 780 is disposed on a side reverse to the blades 786 in the axial length direction of the shaft portion 750.

[0133] The central boss portion 780 of the rotating blade member 708 is constituted by a bottomed hollow shape and is provided with a pipe body 782 having a hollow chamber 781 and a closed wall 783 for closing a front end side of the hollow chamber 781 of the pipe member 782. The central boss portion 780 provided on the side reverse to the blades 786 of the rotating blade member 708, is fixedly press-fitted to an inner portion of the shaft hollow chamber 751 of the shaft portion 750 of the pulley member 704.

[0134] In other words, an outer wall face of the central boss portion 780 of the rotating blade member 708 is press-fitted to an inner wall face partitioning the shaft hollow chamber 751 of the shaft portion 750 of the pulley member 704. The closed wall 783 of the central boss portion 780 of the rotating blade member 708, closes the shaft hollow chamber 751 of the shaft portion 750 of the pulley member 704 and prevents water in the pump chamber 711 from leaking to the shaft hollow chamber 751 of the shaft portion 750.

[0135] Further, the hollow chamber of the pipe body 782 of the rotating blade member 708 is opposed to the pump chamber 711.

[0136] Although according to the above-described embodiment, the central boss portion provided on the side reverse to the blades of the rotating blade member, is fixedly press-fitted to the inner portion of the shaft hollow chamber of the shaft portion of the pulley member, the central boss portion may not necessarily be fixedly

press-fitted thereto but may be fixed thereto by welding or may be fixed thereto by mechanical calking. Although the above-described embodiment is applied to the water pump for delivering and feeding water mounted to the internal combustion engine of a vehicle, the embodiment is applicable also to a water pump for delivering and feeding water mounted to other engine.

(Eighth embodiment)

[0137] Fig. 8 is a sectional view showing an eighth embodiment of applying the invention to a water pump of an engine.

[0138] In Fig. 8, a water pump 801 is constituted by a pulley 810, an impeller 830, a bearing 840, a shaft sealing member (shaft seal) 850, a housing (body) 860 and a seal member 880.

[0139] The pulley 810 is provided with substantially a bottomed cylindrical shape in which an end face on one side (right side of illustration) thereof is opened and which is provided with an end face 810a on other side (left side of illustration).

[0140] A cylindrical face of the pulley 810 is formed with a projected portion 811 projected out wardly in the diameter direction over an entire periphery thereof at the end face 810a (side in the axial direction of the pulley), the diameter of the cylindrical face is contracted and the pulley 810 is formed with a cylindrical face 810b extended to the one side and constituting an engaging face of a belt.

[0141] Further, the end face 810a is provided with a stepped portion 810c a vicinity of a center of which is projected to the one side in a conical shape and a shaft portion (shaft) 820 constituted by further projecting the vicinity of the center of the stepped portion 810c to the one side in a cylindrical shape. Notched portions (communicating holes) 810d as shown by Fig. 8 and Fig. 9 are formed between the stepped portions 810c and the end face 810a for communicating inside and outside of the pulley.

[0142] Here, all of the stepped portions 810c, the shaft portion 820, the projected portion 811 and the belt engaging face 810b are formed concentrically with the pulley 810. The pulley 810 may be formed by pressing a plate-like member such as a steel plate subjected to a corrosion resistant processing or the pulley 810 may be formed by a steel plate and subjected to the corrosion resistant processing after forming. For example, a body portion 864 of the body or housing 860 is formed by pressing or form-rolling process from one sheet of a metal plate member. The pulley 810 having a shaft portion 820 in a shape of a hollow cylinder is formed from one sheet of a metal plate member by a pressing and/or squeezing process.

[0143] The impeller 830 is a so-to-speak open type impeller having a base portion 830b in a shape of a circular disk and several sheets of blades 830c projected therefrom. At center of the base portion 830b of the im-

impeller 830, there is formed a projected portion 830a for inserting to an inner peripheral face of the shaft portion 820. According to the embodiment, the projected portion 830a and the shaft portion 820 are attached to each other unrotatably relative to each other by press-fitting to thereby ensure liquid tightness between a liquid in the housing 860 and outside.

[0144] The housing 860 is constituted by a main body portion 862 having an intake portion 862a, a delivery port, not illustrated, and a recess portion 861 and a body bottom portion 864 attached to an end face of the main body portion 862. The main body portion 862 may be formed by, for example, aluminum die-cast product or may be constituted integrally with a cylinder block or a timing belt case of an engine.

[0145] The body bottom portion 864 is formed substantially in a shape of a circular disk and at a vicinity of a center thereof, there is formed a cylindrical portion 863 having a diameter smaller than an outer diameter of the body bottom portion 864 to project in a direction separating from the main body portion 862. The body bottom portion 864 is formed by pressing a plate-like member such as a steel plate subjected to a corrosion resistant processing. The main body portion 862 and the body bottom portion 864 are coupled by bolts, not illustrated, via the seal member 880. Thereby, there is formed a space maintaining liquid tightness between the recess portion 861 of the main body portion 862 and the body bottom portion 864.

[0146] The space constitutes a water chamber 870 and the impeller 830 is arranged in the water chamber 870.

[0147] An inner peripheral face 863a of the cylindrical portion 863 of the body bottom portion 864, is attached with an outer peripheral face of a shaft sealing member 850 unrotatably relative to each other by press-fitting. Further, an outer peripheral face of the shaft portion 820 is attached with an inner peripheral face of the shaft sealing member 850 unrotatably relative to each other similarly by press-fitting. Here, the inner and the outer peripheral faces of the shaft sealing member 850 are made rotatable relative to each other. The shaft sealing member 850 is a publicly-known mechanical seal.

[0148] Further, an outer peripheral face 863b of the cylindrical portion 863 of the body bottom portion 864 is attached with an inner ring of the bearing 840 unrotatably relative to each other by press-fitting. Meanwhile, an inner peripheral face 810e of the belt engaging face 810b of the pulley 810, is attached with an outer ring of the bearing 840 unrotatably relative to each other by press-fitting. Here, the bearing 840 is a publicly-known rolling bearing.

[0149] Thereby, the pulley 810 is supported by the bearing 840 rotatably relative to the housing 860.

[0150] Next, an explanation will be given of operation of the eighth embodiment.

[0151] The pulley 810 is rotated by rotational force transmitted from an output shaft of an engine, not illus-

trated, via a belt 890 engaged with the belt engaging face 810b of the pulley 810. With rotation of the pulley 810, the shaft portion 820 integrally formed with the pulley 810 is rotated also in the same direction. Further, the impeller 830 integrated with the shaft portion 820 is rotated in the water chamber 870 in the housing 860.

[0152] Now, coolant is filled in the water chamber 870 and therefore, by centrifugal force produced by rotating the impeller 830, the impeller 830 delivers the coolant disposed at a vicinity of a center of the water chamber 870 in an outer peripheral direction of the impeller 830. In this way, there is produced pumping operation by the centrifugal force from the center of the impeller to the outer side. Thereby, there is produced a pressure difference between the vicinity of the rotational center and the outer peripheral side of the impeller 830 in the water chamber 870 and the coolant is sucked from the intake portion 862a provided at the vicinity of the rotational center of the impeller 830 to inside of the water chamber 870.

[0153] Further, the coolant is pressurized to the outer peripheral side by the pumping operation of the impeller 830 and supplied from the delivery port, not illustrated, provided on the outer peripheral side to respective portions to be cooled of the engine.

[0154] Whereas inside of the water chamber 870 is filled with the coolant, the pulley 810 is opened to the atmosphere via the notched portions 810d. However, an interval between the main body portion 862 and the body bottom portion 864 is hermetically sealed by the seal member 880 and an interval between the shaft portion 820 and the body bottom portion 864 is hermetically sealed by arranging the shaft sealing member 850.

[0155] As described above, according to the eighth embodiment, the shaft sealing member 850 is arranged between the inner peripheral face 863a of the cylindrical portion 863 of the body bottom portion 864 and the outer peripheral face of the shaft portion 820 of the pulley 810. Very small leakage of the coolant may be caused in the shaft sealing member 850 as its characteristic.

[0156] For example, when the coolant is leaked at the shaft sealing member 850 in the stationary state of the engine, the leaked coolant passes between the shaft portion 820 and the inner peripheral face 863a of the cylindrical portion 863 and reaches an inner space 812 partitioned in a ring-like shape by the inner peripheral face 810e of the belt engaging face 810b of the pulley 810 and an inner peripheral face 811a of the projected portion 811, the end face 810a and the stepped portion 810c.

[0157] As shown by Fig. 8, a lower side of illustration of the inner space 812 is constituted by the inner peripheral face 810e of the belt engaging face 810b and the inner peripheral face 811a of the projected portion 811. Here, a position in the horizontal direction of illustration of the inner peripheral face 811a of the projected portion 811 is formed to be lower of a position in the horizontal direction of illustration than the inner peripheral face

810e of the belt engaging face 810b. Thereby, the leaked coolant is stored not at the vicinity of the inner peripheral face 810e of the belt engaging face 810b of the inner space 812 but on the side of the inner peripheral face 811a of the projected portion 811.

[0158] Meanwhile, the end face 810a is provided with the notched portions 810d (adjusting means) as shown by Fig. 8 or Fig. 9. At this occasion, the notched portion 810d is opened at a position on a lower side (lower) of illustration than the position in the horizontal direction of illustration of the inner peripheral face 810e of the belt engaging face 810b. Thereby, the leaked coolant is swiftly discharged from the notched portion 810d to outside of the pulley 810. The discharge coolant is conducted at the end face 810a of the pulley 810 and is dropped from an outer peripheral face 811b of the projected portion 811.

[0159] At this occasion, the projected portion 811 is projected to the outer side in the diameter direction over its entire periphery at the side of the pulley 810 in the axial direction and therefore, the coolant does not reach the cylindrical face (belt engaging face) 810b by way of the projected portion 811. Therefore, a deterioration of a rubber member of the belt (swelling or lowering of strength) or adverse influence by a dried substance of a component of the coolant adhered to the belt is not effected and therefore, promotion of life of the belt can be achieved.

[0160] Further, there can be prevented slippage caused by reducing friction force between the belt engaging face and the belt by entering of the coolant and therefore, there can also be prevented occurrence of loss of pump driving torque and occurrence of wear of the belt by slipping the belt.

[0161] Further, although the bearing 840 is arranged between the inner peripheral face 810e of the belt engaging face 810b of the pulley 810 and the outer peripheral face 863b of the cylindrical portion 863, the coolant is not stored at the vicinity of the bearing but stored at the projected portion 811 by the projected portion 811. Therefore, there is not a concern of invasion of the leaked coolant to inside of the bearing 840. Thereby, a deterioration of grease of the bearing or occurrence of corrosion at inside of the bearing can be prevented and therefore, promotion of life of the bearing can be achieved.

(Ninth embodiment)

[0162] Fig. 10 is a sectional view showing a ninth embodiment applying the invention to a water pump of an engine. Further, the ninth embodiment differs from the eighth embodiment only in a constitution of a pulley and therefore, numeral notations constituted by attaching 900 to numeral notations of the eighth embodiment are attached with regard to a constitution the same as that of the eighth embodiment and an explanation thereof will be omitted.

[0163] In Fig. 10, a water pump 901 is constituted by a pulley 910, an impeller 930, a bearing 940, a shaft sealing member 950, a housing 960 and a seal member 980.

5 [0164] The pulley 910 is constituted by a first end face (first ring-like face) 913b formed by bending, by right angle, a cylindrical face (first cylindrical face 913a) substantially in a bottomed cylindrical shape an end face on one side of which is opened and which is provided with
10 an end face 910a on the other side, on the one side, a second cylindrical face 913c formed by bending, by right angle, the first end face 913b and extending the face to other side, a second end face (second ring-like face) 913d formed by bending, by right angle, the second cylindrical face 913c on the other side and a shaft portion
15 (third cylindrical face 920) in a cylindrical shape formed by bending, by right angle, the second end face 913d and extending the face to the one side.

[0165] A belt 990 is engaged with an outer peripheral face 913a1 of the first cylindrical face 913a and the outer
20 peripheral face 913a1 of the first cylindrical face 913a functions as a belt engaging face of the pulley 910. A first ring-like space 912a (first space) having a section in a channel-like shape projected to the one side of the
25 pulley 910, is partitioned by an inner peripheral face 913a2 of the first cylindrical face 913a of the pulley 910, the other end face 910a of the pulley 910, the first end face 913b and an outer peripheral face 913c1 of the second cylindrical face 913c.

30 [0166] The end face 910a of the pulley 910 is a ring-like face orthogonal to the first cylindrical face 913a as shown by Fig. 11, provided by a predetermined length to the center and is opened thereafter.

[0167] Further, there is formed a projected portion 911 produced by projecting the first cylindrical face 913a to
35 an outer side in the diameter direction over an entire periphery, is formed at a vicinity (side in the axial direction of the pulley 910) of a corner portion produced by the end face 910a and the first cylindrical face 913a of
40 the pulley 910.

[0168] Further, there is partitioned a second ring-like space (second space) 912b having a section in a shape of an inverse channel projected to the other side of the
45 pulley 910 by an inner peripheral face 913c2 of the second cylindrical face 913c, the second end face 913b and an outer peripheral face 920a of the shaft portion 920. At a corner portion constituted by the second cylindrical face 913c and the second end face 912b, there is provided a notched portion 910d (communicating portion)
50 for communicating the first ring-like space 912a and the second ring-like space 912b.

[0169] Here, all of the first cylindrical face 913a, the first end face 913b, the second cylindrical face 913c, the second end face 913d, the first and the second ring-like
55 spaces 912a and 912b and the shaft portion 920 are formed concentrically.

[0170] The pulley 910 is formed by forming a plate-like member such as a steel plate subjected to a corro-

sion resistant processing by plastic deformation such as pressing. Or, the pulley 910 may be formed by forming the steel plate by plastic deformation such as pressing and thereafter subjecting the steel plate to corrosion resistant processing.

[0171] Further, an inner ring of the bearing 940 is attached to an outer peripheral face 963b of a cylindrical portion 963 of the body bottom portion 964 unrotatably relative to each other by press-fitting. An outer ring of the bearing 940 is attached to the inner peripheral face 913c2 of the second cylindrical face 913c of the pulley 910 unrotatably relative to each other by press-fitting. Here, the bearing 940 is a publicly-known rolling bearing.

[0172] Thereby, the pulley 910 is supported by the housing 960 rotatably to each other by the bearing 940.

[0173] Next, an explanation will be given of operation of the ninth embodiment.

[0174] Similar to the above-described eighth embodiment, the shaft sealing member 950 is arranged between an inner peripheral face 963a of the cylindrical portion 963 of the body bottom portion 964 and the outer peripheral face 920a of the shaft portion 920 of the pulley 910. Very small leakage of coolant may be caused at the shaft sealing member 950 as its characteristic.

[0175] For example, when leakage is caused in the shaft sealing member 950 in the stationary state of the engine, the leaked coolant passes between the shaft portion 920 and the inner peripheral face 963b of the cylindrical portion 963 and reaches the second ring-like space 912b of the pulley 910. The notched portion (communicating portion) 910d is opened on the lower side of illustration and the left direction of the second ring-like space 912b and therefore, the leaked coolant is conducted to the lower side of illustration via the notched portion 910d.

[0176] The first ring-like space 912a is partitioned at an outer periphery of the second ring-like space 912b. The leaked coolant is conducted to the first ring-like space 912a via the notched portion 910d. Here, the end face 910a of the pulley 910 partitioning the first ring-like space 912a is extended in a diameter contracting direction by a predetermined length and is opened thereafter. Thereby, the leaked coolant is stored in the first ring-like space 912a by a predetermined amount.

[0177] When an amount of the coolant leaked from the shaft sealing member 950 becomes larger than the predetermined amount, the leaked coolant rides over the end face 910a of the pulley 910 and flows from an opening 910b to outside of the first ring-like space 912a. The coolant which has flowed outside thereof is conducted at the end face 910a of the pulley 910 and flows in the lower direction of illustration.

[0178] Further, the coolant reaches the projected portion 911 and is dropped. A position in the horizontal direction of illustration of the outer peripheral face of the projected portion 911 is lower than that of the outer peripheral face 913a1 of the first cylindrical face 913a and

therefore, the coolant does not reach the outer peripheral face 913a1 engaged with the belt 990 by way of the projected portion 911.

[0179] Therefore, there is not caused a deterioration (swelling or lowering of strength) of a rubber material of the belt or adverse influence by a dried substance of a component of the coolant adhered to the belt and therefore, promotion of life of the belt can be achieved.

[0180] Further, there can be also prevented occurrence of loss of pump driving torque caused by slippage by reducing frictional force between the engaging face and the belt by entering of the coolant therebetween or wear of the belt by occurrence of belt slippage.

[0181] Further, although the bearing 940 is arranged between the cylindrical portion 963 and the inner peripheral face 913c2 of the second cylindrical face 913c in the second ring-like space 912b, by the notched portions 910d, the coolant leaked from the shaft sealing member 950 is not stored in the second ring-like space 912b but immediately flows to the first ring-like space 912a.

[0182] Therefore, there is not a concern of invasion of the leaked coolant to inside of the bearing 940. Thereby, corrosion of inside of the bearing or deterioration of grease can be prevented and therefore, promotion of life of the bearing can be achieved.

[0183] As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

Claims

1. A water pump comprising:

a pulley rotated by receiving a torque from a drive source and having a shaft portion which is integrally formed therewith and extended in a shaft core direction at a central portion thereof;
an impeller fixed to the shaft portion and rotated integrally with the shaft portion;
a body forming a water chamber arranged with the impeller;
a cylindrical portion provided by projecting from the body in a cylindrical shape;
a bearing rotatably supporting the pulley at the cylindrical portion; and
a shaft sealing member for sealing the bearing against the water chamber;

wherein the shaft sealing member is attached to either one of an inner peripheral face and an outer peripheral face of the cylindrical portion.

2. The water pump according to Claim 1:
wherein an outer ring of the bearing is attached to an inner peripheral face of the pulley, an inner ring thereof is attached to an outer peripheral face of the cylindrical portion and the shaft sealing member is attached to an inner peripheral face of the cylindrical portion.
3. The water pump according to Claim 2:
wherein a portion of the impeller attached to the shaft portion is constituted in a bag-like shape and an end face of the shaft portion on a side fixed to the impeller is opened.
4. The water pump according to Claim 2 or 3:
wherein the cylindrical portion is provided integrally with a portion constituting a diameter smaller than an outer diameter of the shaft sealing member.
5. The water pump according to Claim 2 or 3:
wherein the cylindrical portion is integrally provided with a portion constituting a diameter larger than an inner diameter of the bearing.
6. The water pump according to any one of Claims 2 through 5:
wherein the cylindrical portion is provided with a large diameter portion and a small diameter portion, the bearing is attached to an outer peripheral face of the small diameter portion and the shaft sealing member is attached to an inner peripheral face of the large diameter portion.
7. The water pump according to Claim 1:
wherein the shaft portion includes a hollow chamber, the impeller includes a central boss portion and blades and the central boss portion is fitted to an inner portion or an outer portion of the shaft hollow chamber of the shaft portion.
8. The water pump according to Claim 1:
wherein the impeller includes a central boss portion in a bottomed hollow shape having a closed wall and blades projected in a direction reverse to the central boss portion in an axis length direction of the shaft portion, the central boss portion of the impeller is fitted to an inner portion of a shaft hollow chamber of the shaft portion and the shaft hollow chamber of the shaft portion is closed in an uncommunicated state by closed wall.
9. The water pump according to Claim 2:
wherein the pulley is provided with a projected portion projected to an outer side in a diameter direction in a space between the shaft sealing member and the bearing.
10. The water pump according to Claim 9:
wherein the projected portion is provided on a side of a belt engaging face of the pulley in an axial direction of the pulley.
11. The water pump according to Claim 9 or 10:
wherein an inner peripheral face of the projected portion forms a storing portion for storing a predetermined amount of a liquid, further comprising:
means for adjusting a level of the liquid stored in the storing portion to be always lower than an inner peripheral face of the belt engaging face.
12. The water pump according to any one of Claims 9 through 11:
wherein the pulley comprising:
a first space in a ring-like shape at least one face of which is formed by the inner peripheral face of the belt engaging face;
a second space in a ring-like shape at least one face of which is formed by an inner peripheral face of the pulley attached with the bearing; and
a communicating portion for communicating the first space and the second space.
13. The water pump according to Claim 12:
wherein the pulley comprising:
a first cylindrical face constituting the belt engaging face, a second cylindrical face constituting the inner peripheral face of the pulley attached with the bearing and a first ring-like face connecting the first and the second cylindrical faces;
a third cylindrical face constituting the shaft; and
a second ring-like face connecting the second cylindrical face and the third cylindrical face;
wherein the communicating portion for communicating the first and the second spaces is provided at least either of the second ring-like face and the second cylindrical face.
14. The water pump according to Claim 12 or 13:
wherein the first and the second spaces are formed integrally with the shaft by bending the pulley by a plurality of times.

FIG. 1

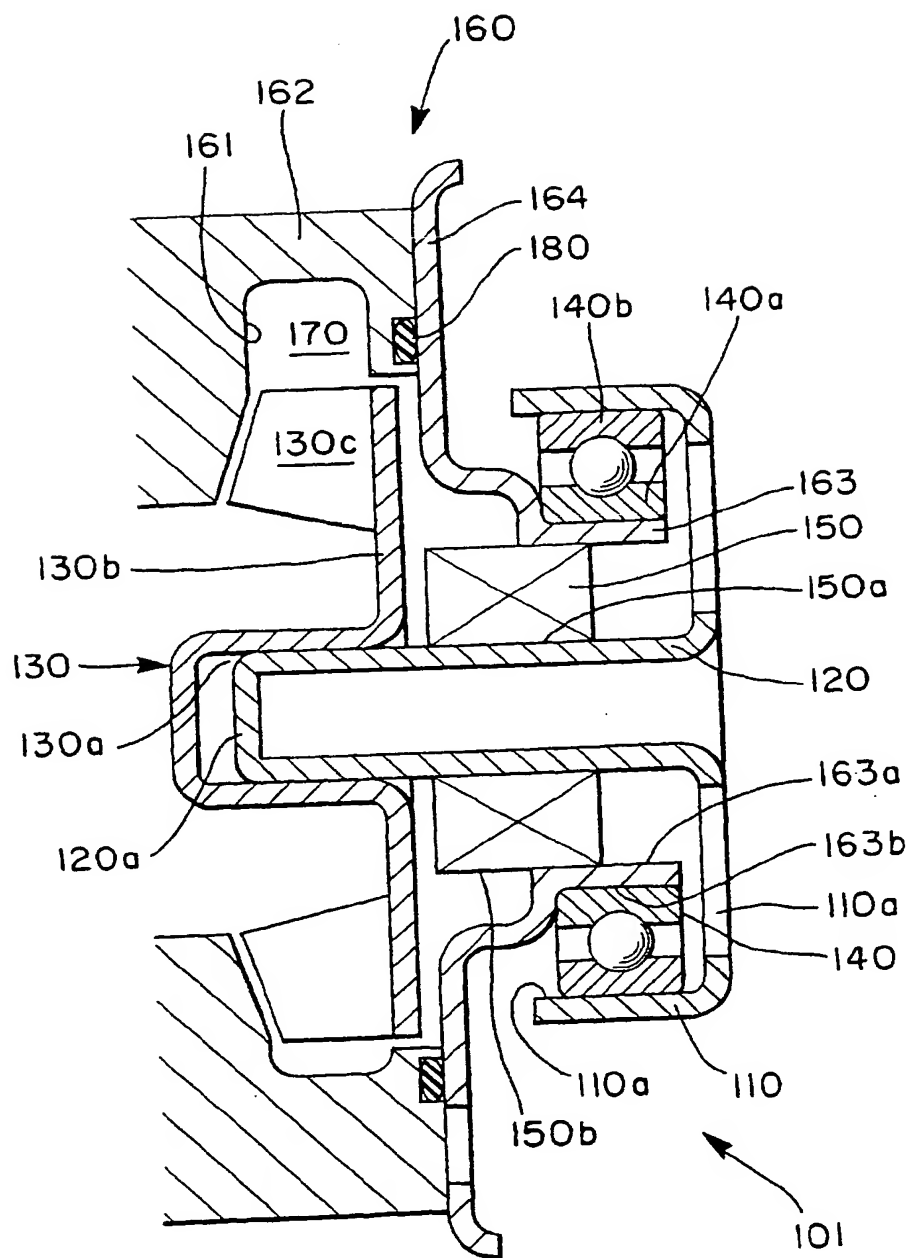


FIG. 2

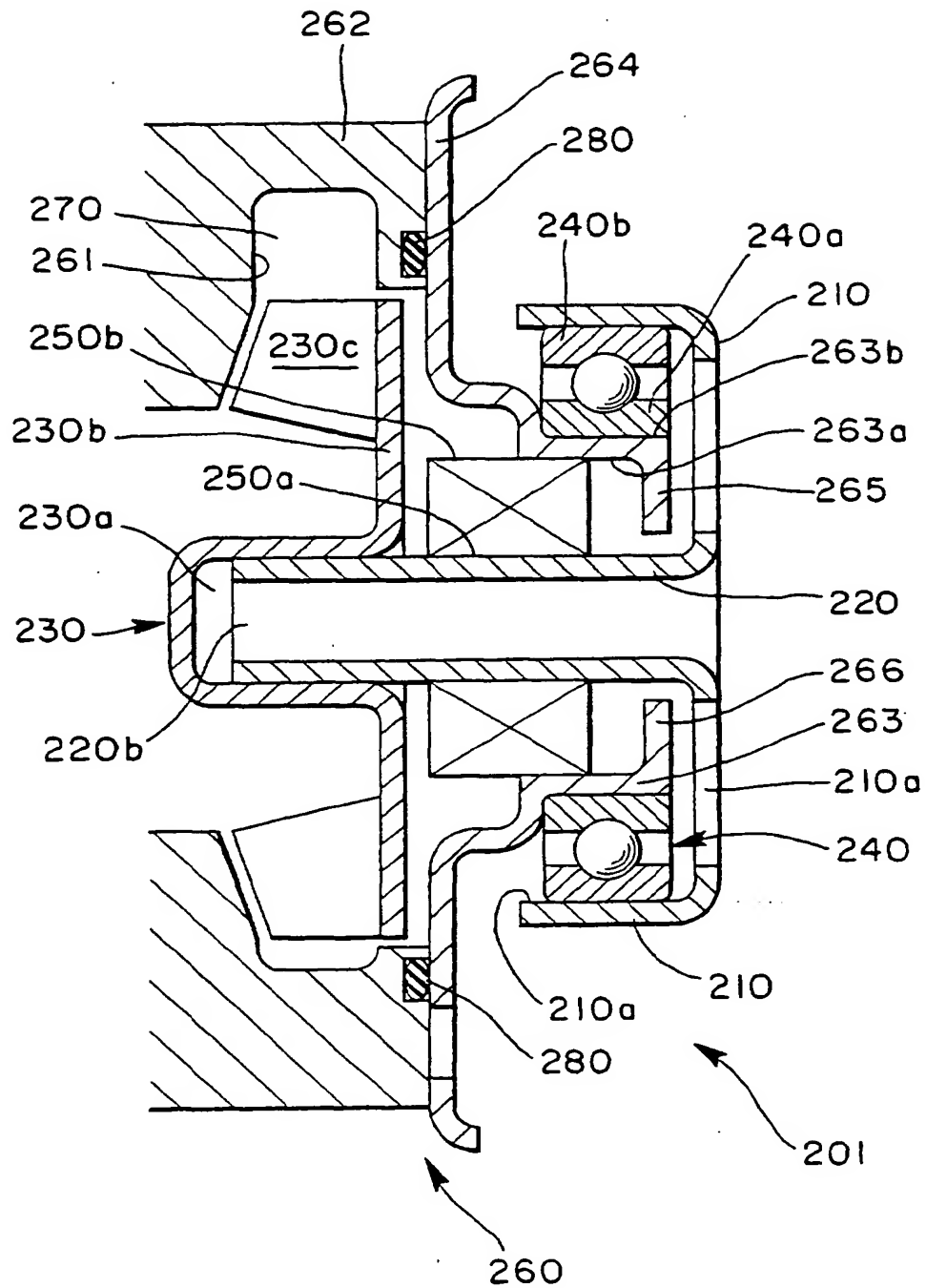


FIG. 3

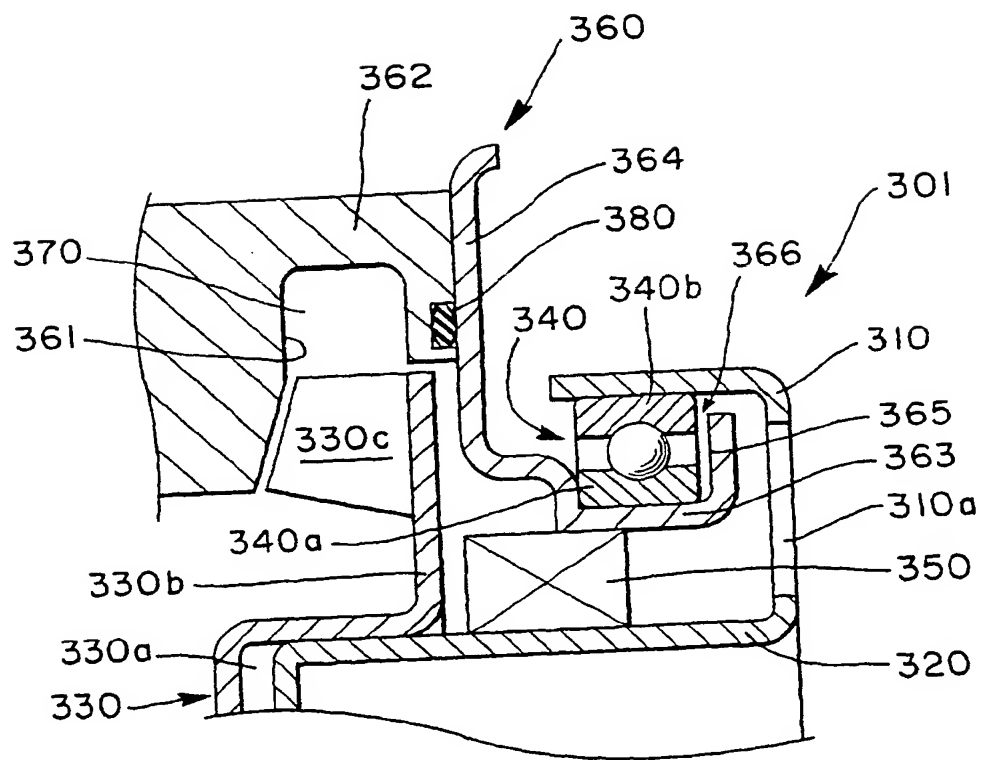


FIG. 4

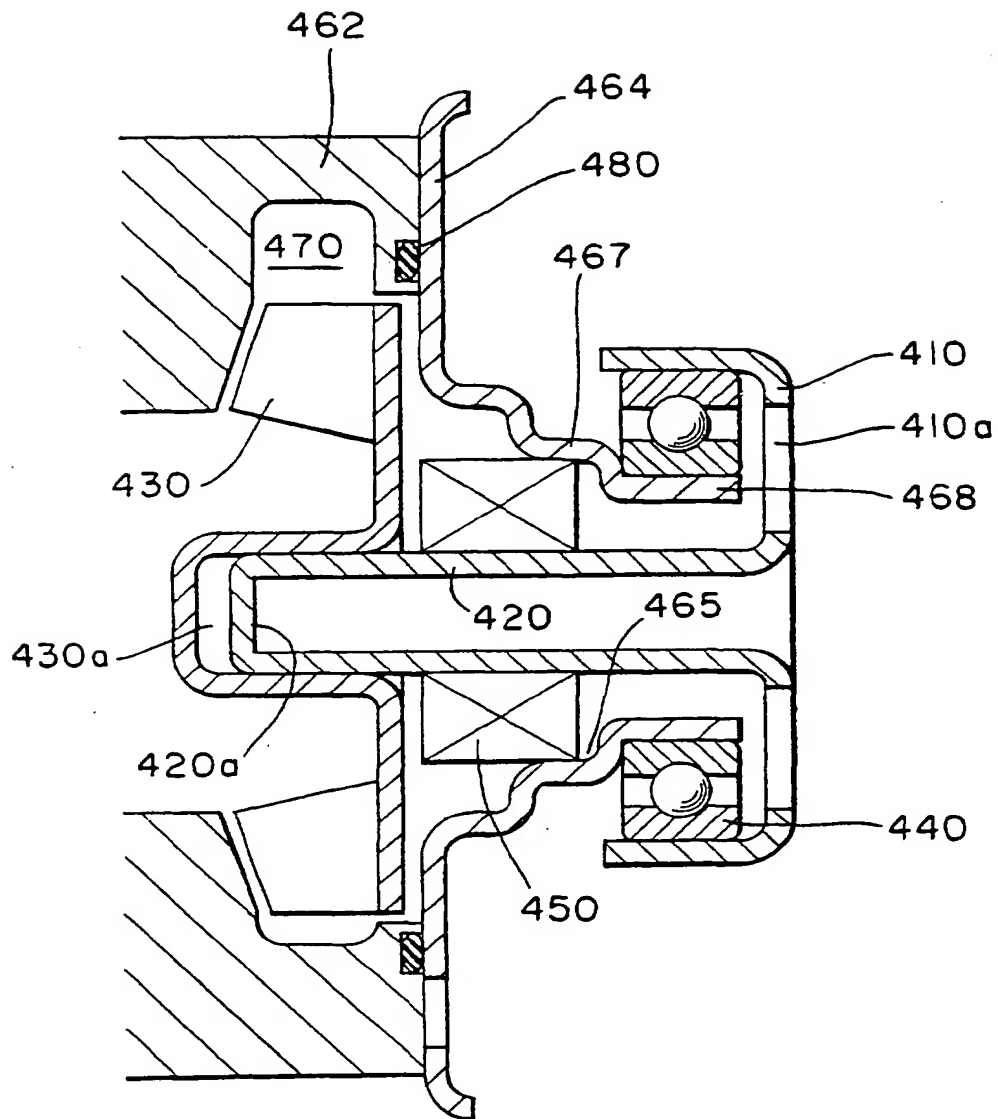


FIG. 5

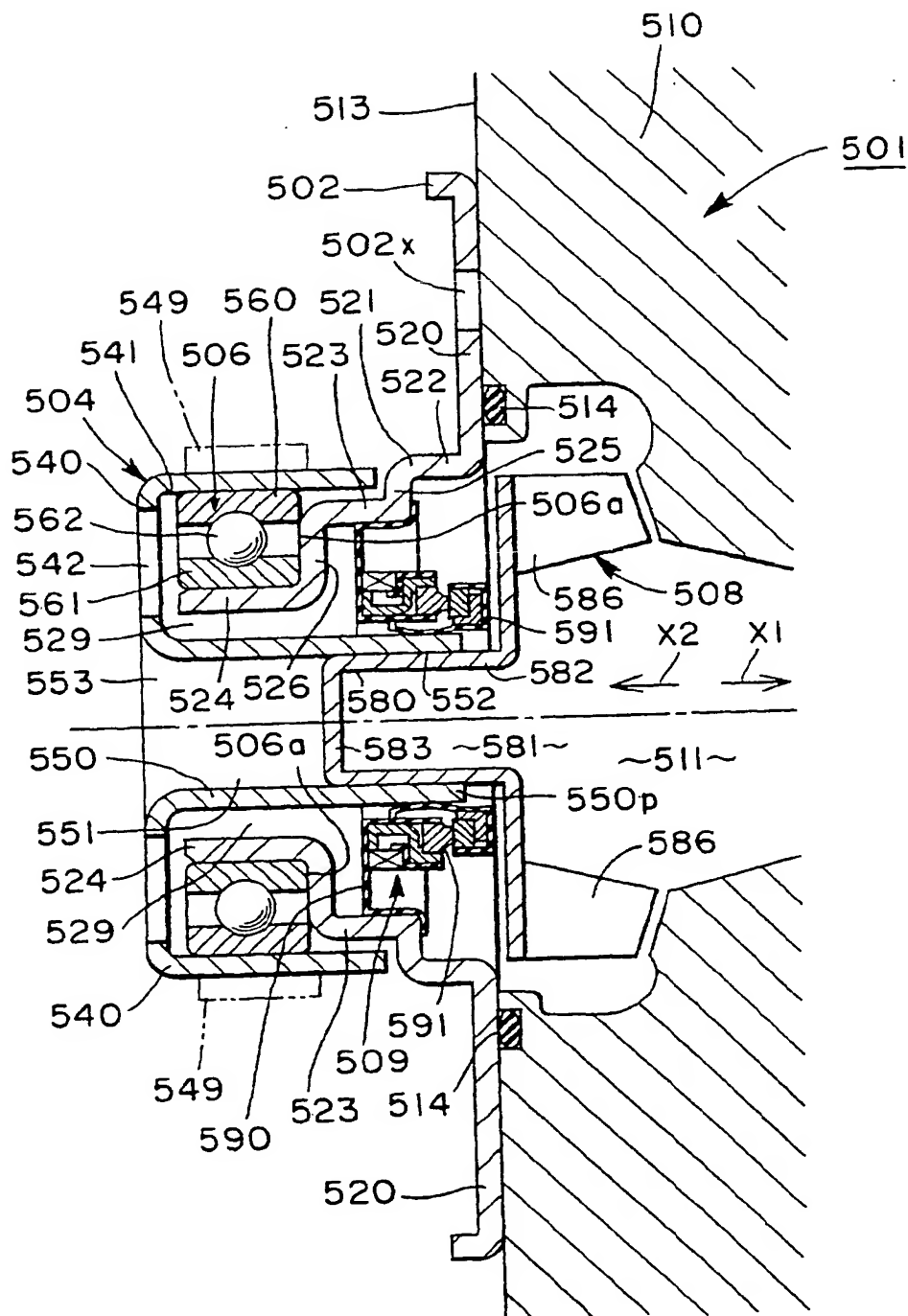


FIG. 6

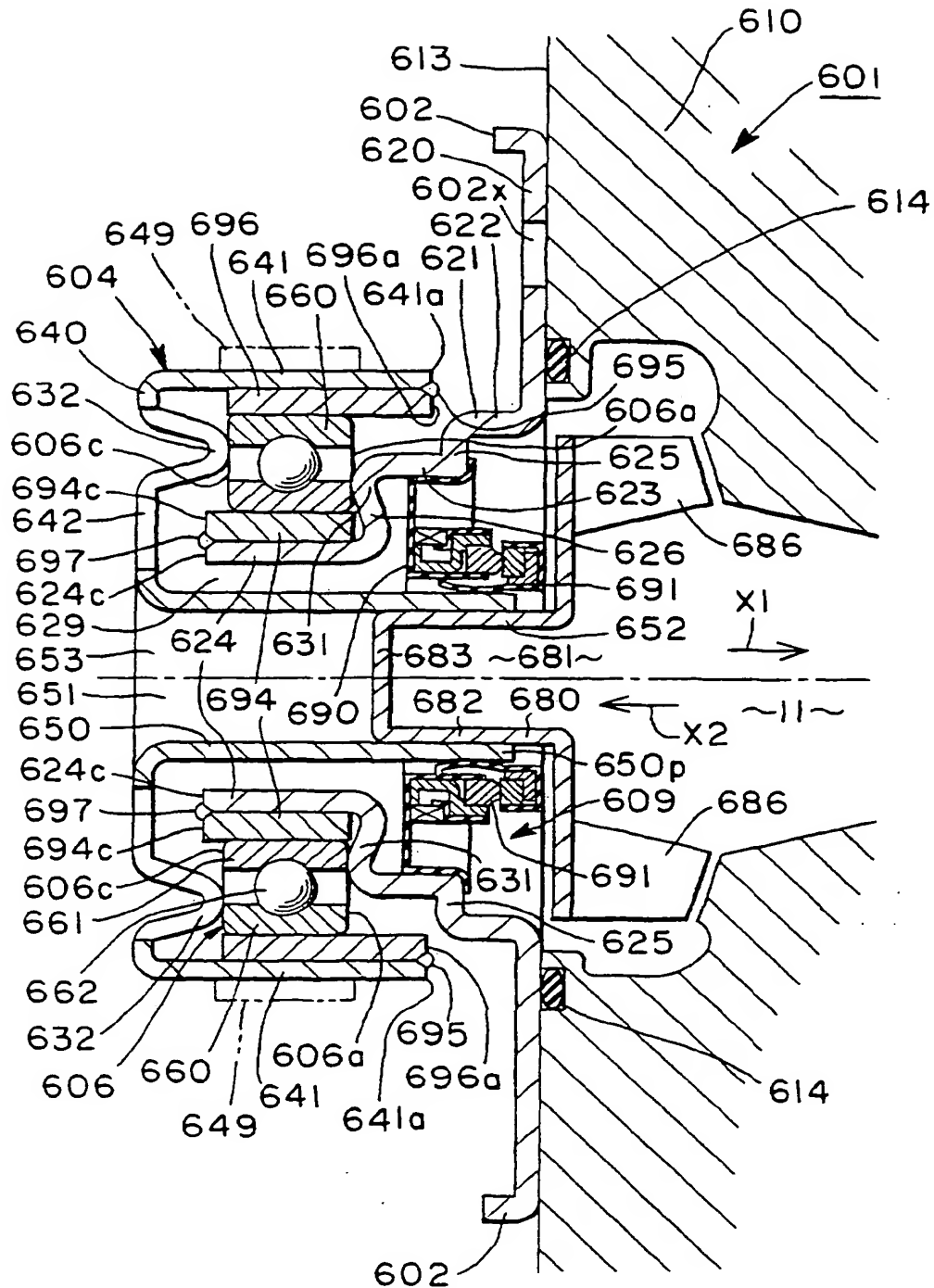


FIG. 8

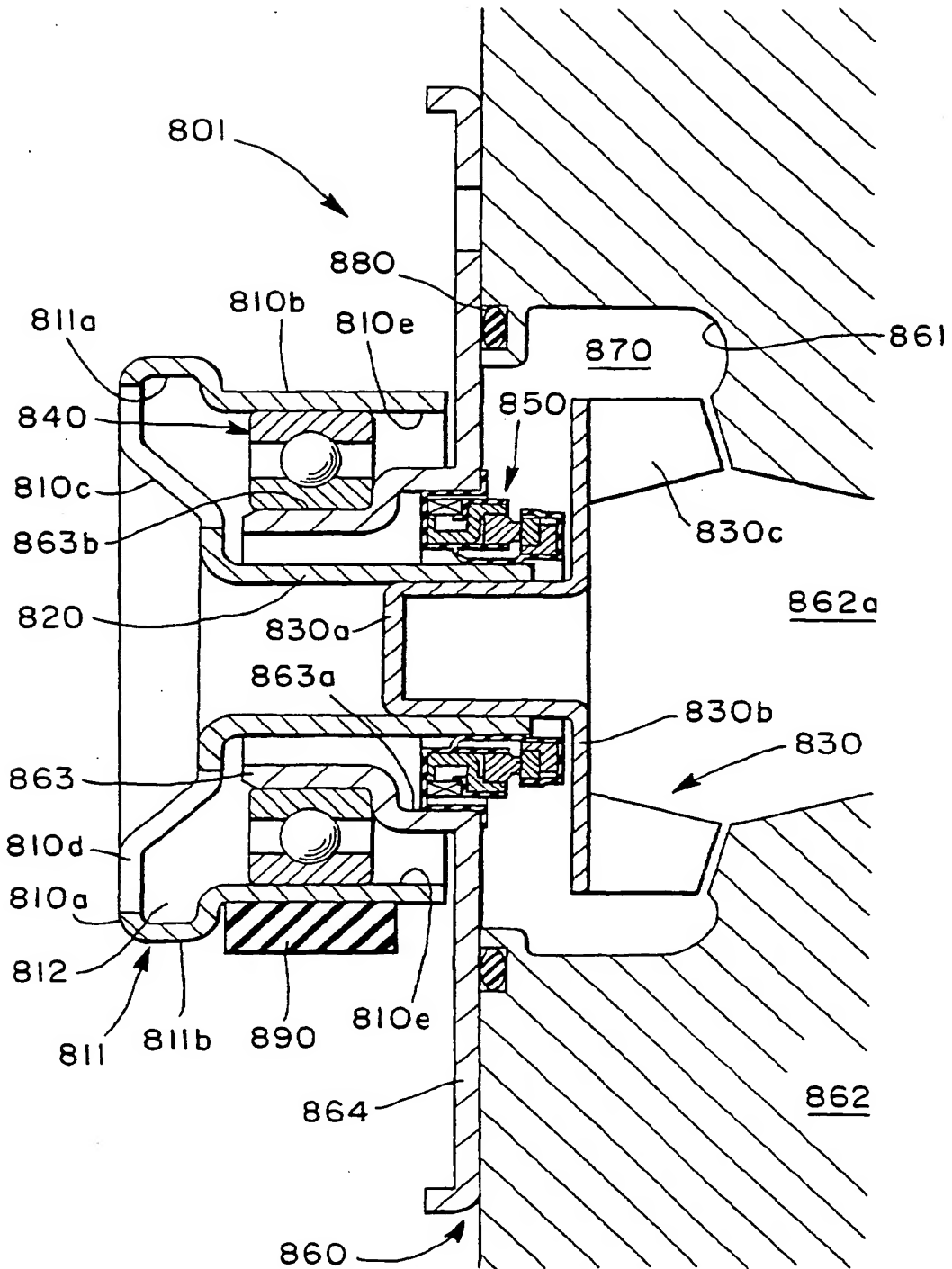


FIG. 9

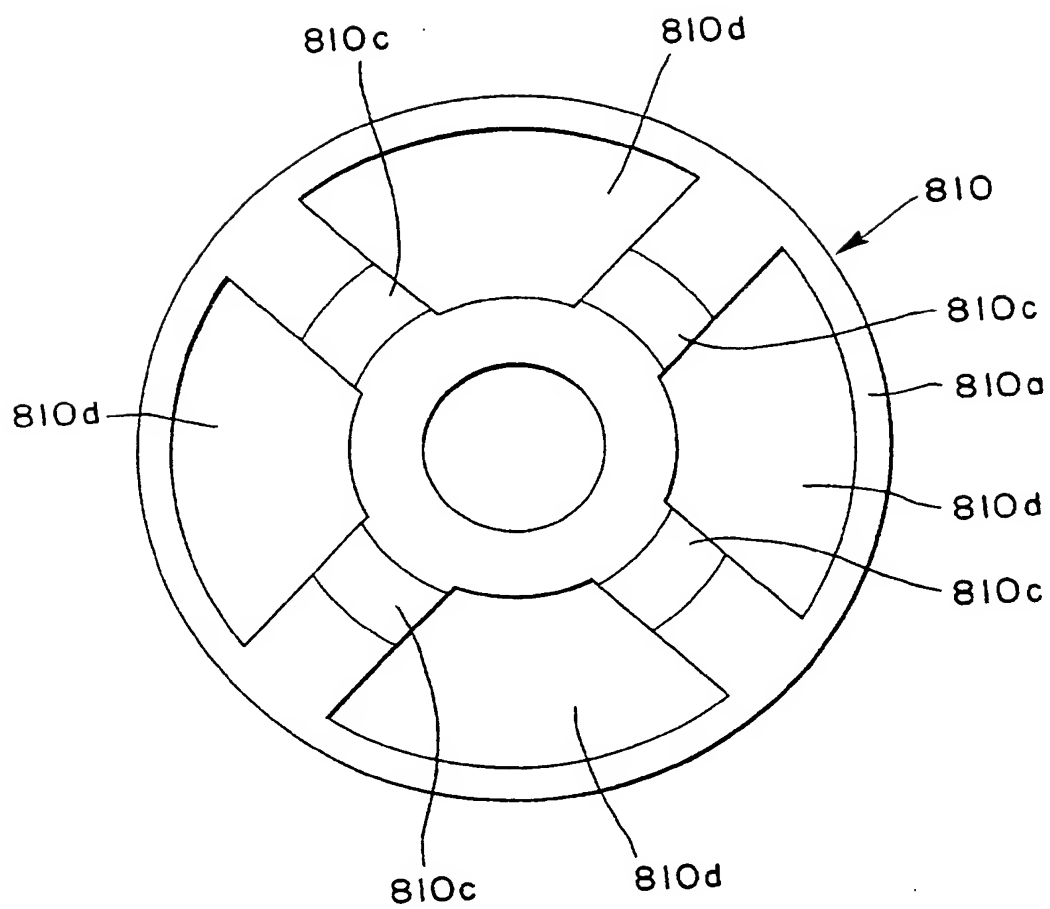


FIG. 10

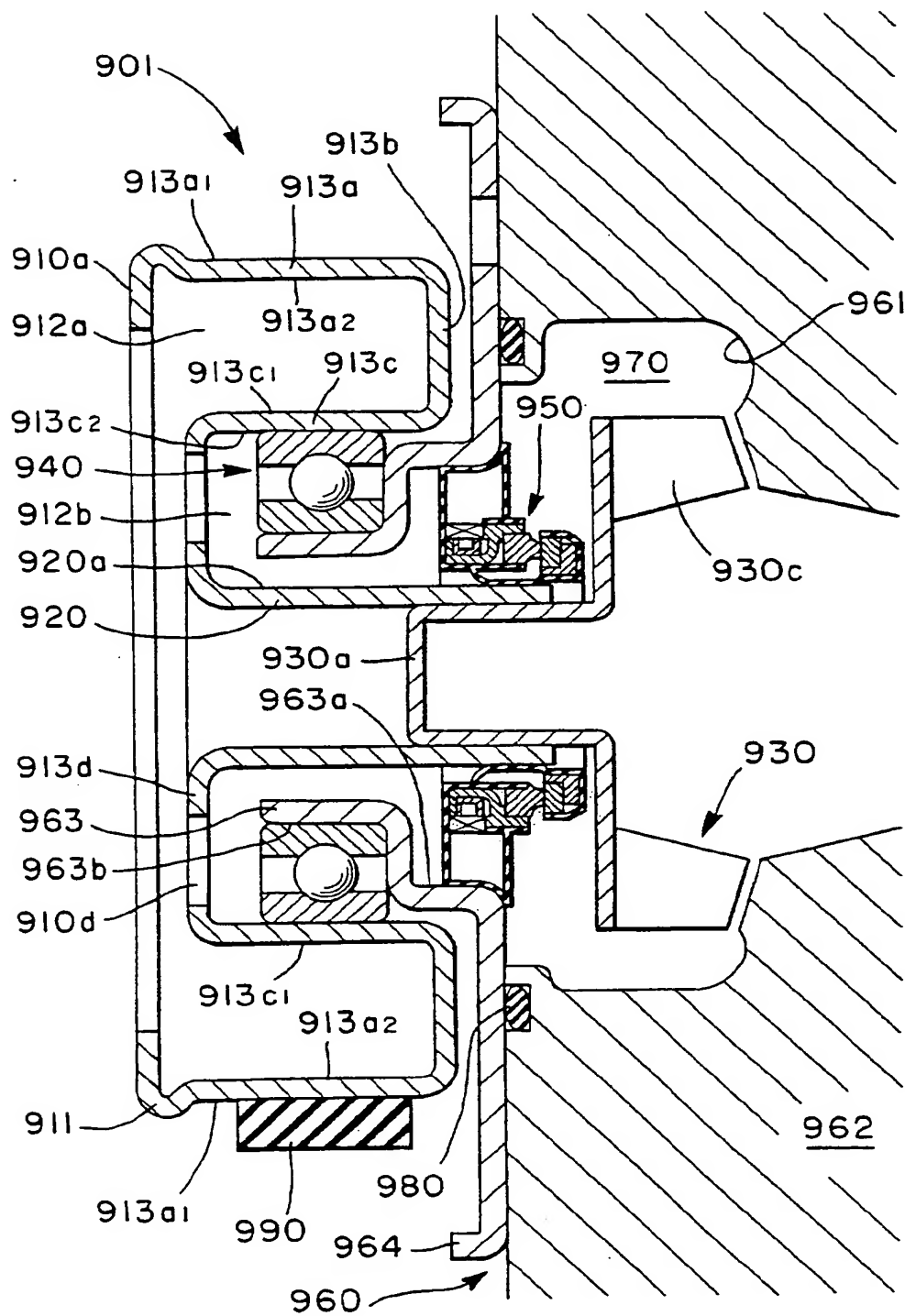


FIG. 11

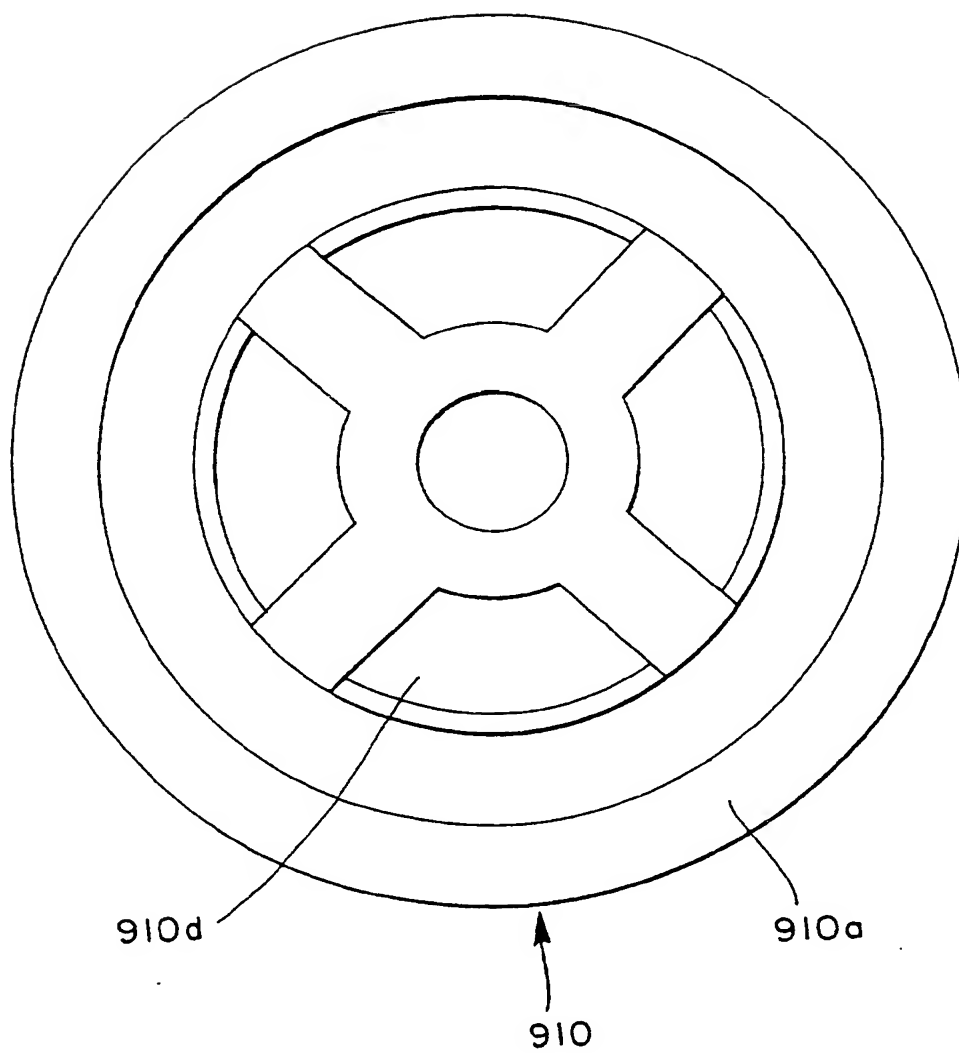
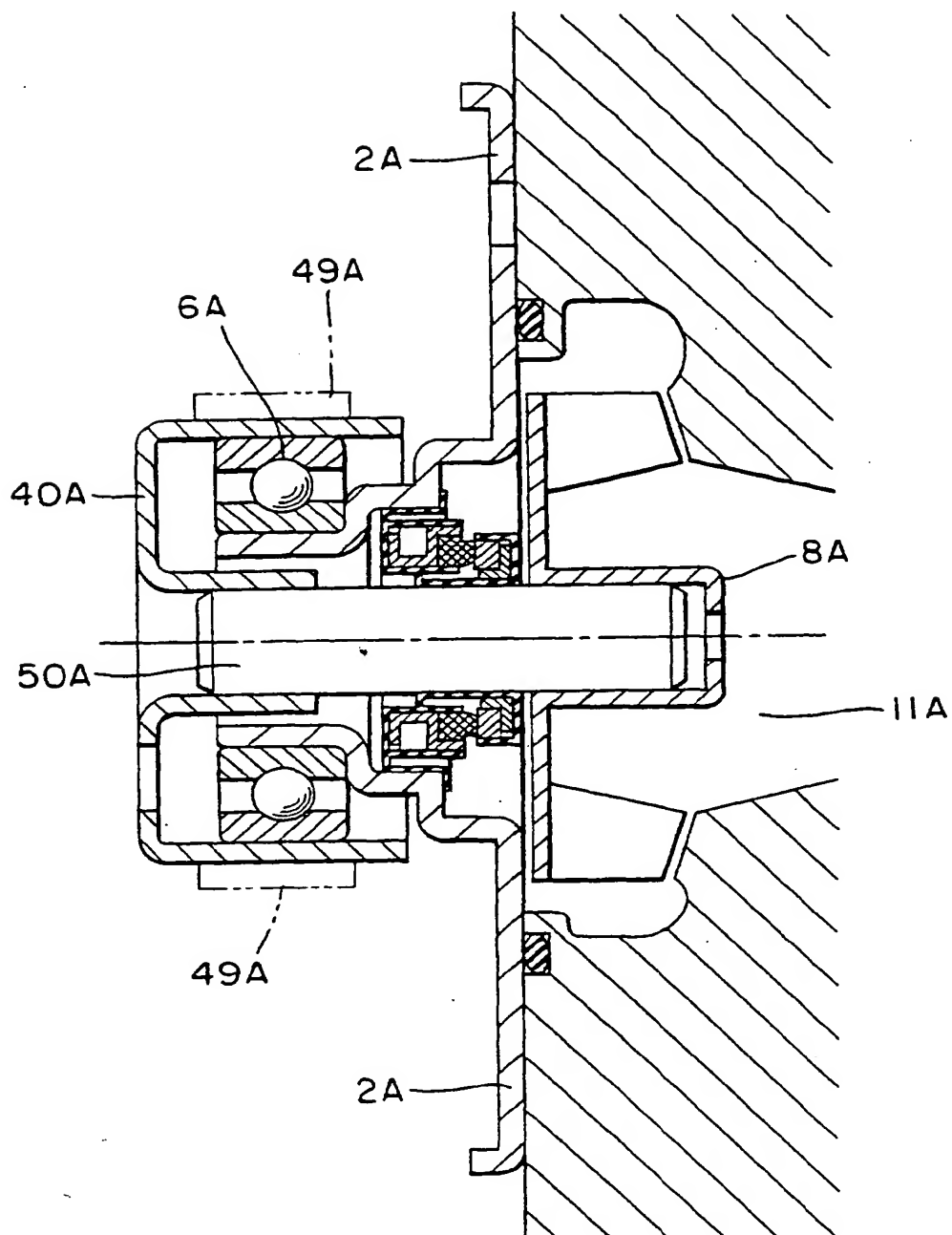


FIG. 12
PRIOR ART



THIS PAGE BLANK (USPTO)



(12)

EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
12.11.2003 Bulletin 2003/46

(51) Int Cl.7: **F04D 29/04**, F04D 29/10,
F04D 29/20, F16H 55/44

(43) Date of publication A2:
20.03.2002 Bulletin 2002/12

(21) Application number: 01122201.5

(22) Date of filing: 17.09.2001

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
 MC NL PT SE TR**
 Designated Extension States:
AL LT LV MK RO SI

- Chiba, Atsushi
Toyoake-shi, Aichi-ken (JP)
- Chujo, Masaki
Chiryu-shi, Aichi-ken (JP)
- Yamamoto, Junya
Toyota-shi, Aichi-ken (JP)

(30) Priority: 19.09.2000 JP 2000284017
17.11.2000 JP 2000351665
09.03.2001 JP 2001067566

(74) Representative: **Barske, Heiko, Dr. rer. nat.**
Blumbach, Kramer & Partner
Patentanwälte
Radeckestrasse 43
81245 München (DE)

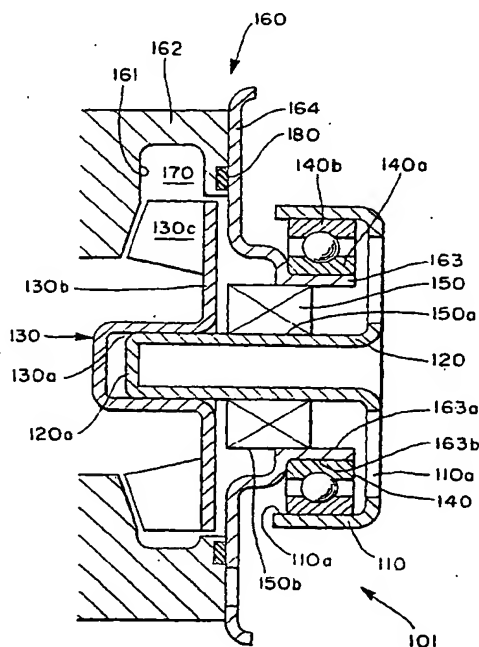
(71) Applicant: AISIN SEIKI KABUSHIKI KAISHA
Kariya-shi Aichi-ken (JP)

(72) Inventors:
• **Ozawa, Yasuo**
Kariya-shi, Aichi-ken (JP)

(54) **Water pump**

(57) To provide a water pump capable of preventing coolant leaked from a shaft sealing member from invading a bearing by a simple constitution, in a water pump 101 in which an outer ring 140b of a bearing 140 is attached to an inner peripheral face 110a of a pulley 110, an inner ring 140a of the bearing 140 is attached to an outer peripheral face 163b of a cylindrical portion 163 of a housing 160 and a shaft sealing member 150 is attached to an inner peripheral face 163a of the cylindrical portion 163.

FIG. 1





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 12 2201

DOCUMENTS CONSIDERED TO BE RELEVANT			Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Category	Citation of document with indication, where appropriate, of relevant passages			
X	US 5 026 253 A (BOERGER HERBERT) 25 June 1991 (1991-06-25)	1,2,4-6, 9,10	F04D29/04 F04D29/10 F04D29/20 F16H55/44	
Y	* the whole document * * column 6, line 5 - line 37; figure 7 *	7,8		
Y	EP 0 289 958 A (KOYO SEIKO CO) 9 November 1988 (1988-11-09) * the whole document * * figure 11 * * figures 10,13,14 *	7,8		
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 378 (M-546), 17 December 1986 (1986-12-17) -& JP 61 169699 A (YAMADA SEISAKUSHO:KK), 31 July 1986 (1986-07-31) * abstract *	3		
X	US 5 224 823 A (CORDTS DETLEF) 6 July 1993 (1993-07-06) * figures 1,2 *	1,2,4-6	TECHNICAL FIELDS SEARCHED (Int.Cl.7)	
X	US 3 981 610 A (ERNST HORST M ET AL) 21 September 1976 (1976-09-21) * figures 1,2 *	1,2,4-6	F04D F01P F16H	
X	US 3 871 790 A (RAMEAU JEAN) 18 March 1975 (1975-03-18) * figures 2,3 *	1,2,4-6		
D,X	PATENT ABSTRACTS OF JAPAN vol. 017, no. 043 (M-1360), 27 January 1993 (1993-01-27) -& JP 04 262096 A (HONDA MOTOR CO LTD), 17 September 1992 (1992-09-17) * abstract *	1,2		
The present search report has been drawn up for all claims				
Place of search THE HAGUE		Date of completion of the search 19 September 2003	Examiner Ingelbrecht, P	
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>				

EPO FORM 1503 03 82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 12 2201

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (InLCI.7)
A	DE 41 00 507 C (MERCEDES-BENZ AG) 14 May 1992 (1992-05-14) * the whole document *	11-13	
A	EP 0 945 624 A (TCG UNITECH AKTIENGESELLSCHAFT) 29 September 1999 (1999-09-29) * the whole document *	11-13	
A	US 3 124 090 A (F.ZATYKO) 10 March 1964 (1964-03-10) * the whole document *	14	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19 September 2003	Examiner Ingelbrecht, P
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 1503.03.82 (P04C01)



European Patent
Office

Application Number

EP 01 12 2201

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



European Patent
Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 01 12 2201

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claim : 3 with 1 and 2

Water pump according to claims 1 and 2 characterised by an impeller portion constituted in a bag like shape and an end face of the shaft portion on a side fixed to the impeller being opened

2. Claims: 7,8 with 1

Water pump according to claim 1 characterised by a hollow shaft to which the central boss of the impeller is fitted either on the inner or on the outer portion thereof

3. Claims: 9-14 with 1 and 2

Water pump according to claims 1 and 2 characterised by the pulley having a projected portion projected to an outer side in a diameter direction in a space between the shaft sealing member and the bearing

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 01 12 2201

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-09-2003

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5026253	A	25-06-1991	DE 3822702 A1	15-03-1990
			BR 8903291 A	25-09-1990
			EP 0349702 A2	10-01-1990
			JP 2064293 A	05-03-1990
			JP 2092425 C	18-09-1996
			JP 8001188 B	10-01-1996
			MX 173619 B	18-03-1994
EP 0289958	A	09-11-1988	JP 1887366 C	22-11-1994
			JP 6010478 B	09-02-1994
			JP 63277899 A	15-11-1988
			JP 1053095 A	01-03-1989
			JP 1053097 A	01-03-1989
			JP 1053096 A	01-03-1989
			DE 3869187 D1	23-04-1992
			EP 0289958 A2	09-11-1988
			ES 2029696 T3	01-09-1992
			US 4824324 A	25-04-1989
JP 61169699	A	31-07-1986	NONE	
US 5224823	A	06-07-1993	DE 4040200 A1	17-06-1992
			AT 104022 T	15-04-1994
			DE 59101330 D1	11-05-1994
			DK 491130 T3	02-05-1994
			EP 0491130 A1	24-06-1992
			ES 2051063 T3	01-06-1994
US 3981610	A	21-09-1976	FR 2250035 A1	30-05-1975
			GB 1476348 A	10-06-1977
			IT 1024731 B	20-07-1978
			JP 50074801 A	19-06-1975
US 3871790	A	18-03-1975	FR 2230225 A5	13-12-1974
			BE 813953 A1	16-08-1974
			DE 2423383 A1	28-11-1974
			ES 426216 A1	01-07-1976
			GB 1456938 A	01-12-1976
			IT 999941 B	10-03-1976
			RO 64584 A1	15-02-1980
			TR 18190 A	22-11-1976
JP 04262096	A	17-09-1992	JP 2967369 B2	25-10-1999
			US 5217350 A	08-06-1993
DE 4100507	C	14-05-1992	DE 4100507 C1	14-05-1992

EPO FORM P/459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 12 2201

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-09-2003

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0945624	A	29-09-1999	AT 221623 T	15-08-2002
			DE 59902165 D1	05-09-2002
			EP 0945624 A2	29-09-1999
			US 6200089 B1	13-03-2001
<hr/>				
US 3124090	A	10-03-1964	NONE	
<hr/>				

EPO FORM 19459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

THIS PAGE BLANK (USPTO)



P.B.5818 - Patentlaan 2
2280 HV Rijswijk (ZH)
☎ +31 70 340 2040
TX 31651 epo nl
FAX +31 70 340 3016

Europäisches
Patentamt

Zweigstelle
in Den Haag
Recherchen-
abteilung

European
Patent Office

Branch at
The Hague
Search
division

Office européen
des brevets

Département à
La Haye
Division de la
recherche

Kramer - Barske - Schmidtchen
European Patent Attorneys
Patenta
Radeckestrasse 43
81245 München
ALLEMAGNE

PATENTA
MÜNCHEN

06. Mai 2005

RE:
WV: 06.10.05
FRIST:

NOT: ~~fe~~

Datum/Date

03.05.05

Zeichen/Ref./Réf. 04/87150 EP	Anmeldung Nr./Application No./Demande n°/Patent Nr./Patent No./Brevet n°. 04009322.1-2315-
Anmelder/Applicant/Demandeur/Patentinhaber/Proprietor/Titulaire Aisin Seiki Kabushiki Kaisha	

COMMUNICATION

The European Patent Office herewith transmits as an enclosure the European search report for the above-mentioned European patent application.

If applicable, copies of the documents cited in the European search report are attached.

☒ Additional set(s) of copies of the documents cited in the European search report is (are) enclosed as well.

The following specifications given by the applicant have been approved by the Search Division:

☒ abstract

☒ title

☐ The abstract was modified by the Search Division and the definitive text is attached to this communication.

The following figure will be published together with the abstract:

1

REFUND OF THE SEARCH FEE

If applicable under Article 10 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.



THIS PAGE BLANK 00770



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	EP 1 188 931 A (AISIN SEIKI KABUSHIKI KAISHA) 20 March 2002 (2002-03-20) * the whole document *	1	F04D29/66
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 378 (M-546), 17 December 1986 (1986-12-17) & JP 61 169699 A (YAMADA SEISAKUSHO:KK), 31 July 1986 (1986-07-31) * abstract *	1	
A	US 2002/176773 A1 (OZAWA YASUO ET AL) 28 November 2002 (2002-11-28) * the whole document *	1	
A	US 4 966 572 A (KUNKEL ET AL) 30 October 1990 (1990-10-30) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F04D F01P
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 April 2005	Examiner Giorgini, G
<div>CATEGORY OF CITED DOCUMENTS</div> <div>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</div> <div>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</div>			

THIS PAGE BLANK (USPTO)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 04 00 9322

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-04-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1188931 A	20-03-2002	JP 2002089486 A	27-03-2002
		JP 2002155893 A	31-05-2002
		JP 2002266793 A	18-09-2002
		CN 1346023 A ,C	24-04-2002
		EP 1188931 A2	20-03-2002
		US 2002034438 A1	21-03-2002
JP 61169699 A	31-07-1986	NONE	
US 2002176773 A1	28-11-2002	JP 2002349481 A	04-12-2002
		EP 1267080 A1	18-12-2002
US 4966572 A	30-10-1990	DE 3825633 A1	01-02-1990
		FR 2634830 A1	02-02-1990
		GB 2223279 A ,B	04-04-1990
		IT 1232872 B	05-03-1992
		JP 2045698 A	15-02-1990

THIS PAGE BLANK (USPTO)